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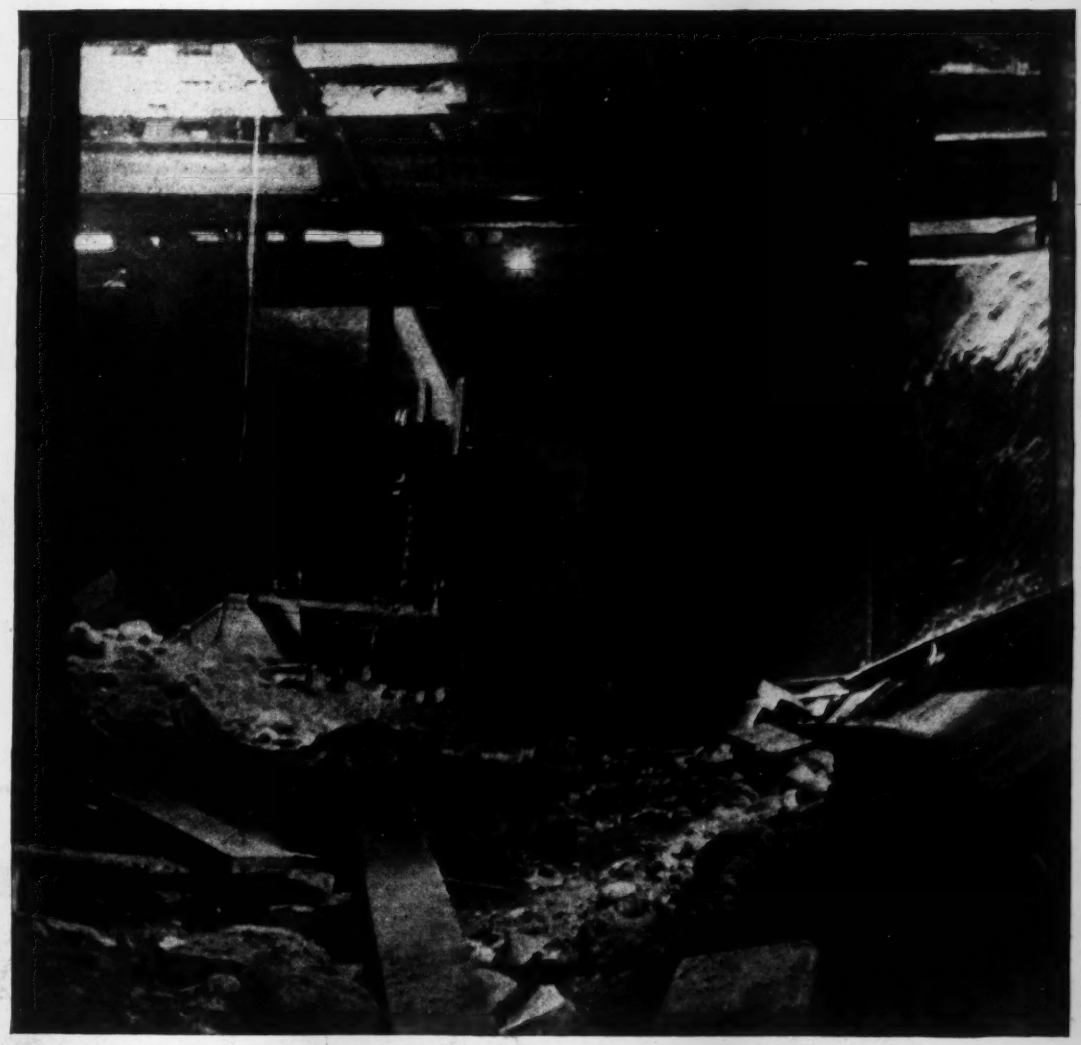
October 7, 1926

Engineering News-Record



Power Shovel on Subway Construction Working Under Timber Street Decking

Compact Plant Arrangement for Building Hotel Foundation—Timbering for Power Shovel Excavation and Truck Haulage, by Leo M. Charm: Another Article in the Series on Subway Construction in New York City—Highway Warning Symbols That Require No Reading, by E. T. Scott—Bridging the Delaware River at Philadelphia-II

Also: Structural Effects of Florida Hurricane—A Staff Study

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FRANK C. WIGHT
Editor

Volume 97 NEW YORK, OCTOBER 7, 1926 Number 15

Staging a Centenary

A LITTLE late, though proverbially better than not at all, the state of New York is this week to celebrate the hundredth anniversary of the Erie Canal. The main line of that waterway was opened in October, 1825, with the famous procession of boats bearing the water of Lake Erie to be emptied into the Atlantic. The state last year tried to get going in time to celebrate a real centennial but apparently it was not possible to get down to action until a year after the accepted interval had passed. However, enough money was appropriated to pay the expenses of a committee, with its stationery, staff, and correspondence, and to stage an imitative procession of boats and, within the limits of our modern sumptuary law, a fac-simile of the celebration banquet of 1825. All of which is fitting. New York's commercial supremacy clearly dates back to the Erie Canal opening. Whether it was the real cause or not is lost in the questionings of what might have been, but a simple tribute to a past glory is well worth while. Let us, though, keep our sense of proportion and remember it is history to which we make our bow and not economics—and that 1926 is not 1825. Pray we may be spared too much oratory and literature which will draw the lesson of a primitive era made live by a new means of transport as proof of a needed resurrection in this vastly different modern world.

Too Long Deferred

YEARS ago an efficient water engineer tried to convince his superiors in the city government of Albany, N. Y., that universal metering would pay. Little heed seems to have been given to the facts and figures then marshalled. Meters would have greatly lessened the overburden that soon came on the filters. Now that the city is on the eve of spending a large sum for a new upland source of water supply the special water commission has in mind a meter program which, it is said, would reduce the water consumption and waste from the present 170 to 140 gal. per capita, and materially extend the time that the first unit in the new supply would be ample to serve the city. It is to be hoped that the long-deferred meter plan will be put into effect immediately.

Water Hammer in Penstocks

THREE hydro-electric plants of notably high heads are now under construction in California; the Balch plant on the San Joaquin Light & Power system, static head 2,281 ft.; the Big Creek 2-A plant on the Southern California Edison system, static head 2,419 ft., and the Buck's Creek plant of the Feather River Power Co., static head 2,548 ft. The designs for these plants constitute a reminder that the maximum water hammer possible in a penstock is equal to the pressure that would be caused by imposing on it an additional static head of somewhere between 1,500 and 2,500 ft., that is, that the maximum water hammer is a constant independent of the head. These are facts well known to engineers who deal frequently with the hydraulic formulas involved, of course, but they are worthy of general attention now that a point has been reached, as the result of progress toward higher and smaller heads, where the danger of water hammer has ceased to be a factor in some penstock design. Elsewhere in this issue the relation of maximum water hammer and static head is shown graphically. The danger of water hammer always should be carefully considered down to the point where its maximum value is not critical; however, in the recent very high head installations a considerable part of the penstock and the most costly pipe sections are subject to heads at which water hammer can be ignored altogether since the stresses that maximum water hammer would produce are within the safe limits of strength provided for other reasons.

Stop Skimping Engineer's Pay

ONE of the declarations of the recently announced Municipal and Economy Commission representing nine commercial organizations of New York City is: "No careful study to make the tax dollar go further has even been pretended by the city officials." Unfortunately state and federal officials are generally open to such a charge. Occasionally, an efficiency and economy commission is appointed. Some of them have made good reports. As a rule the matter stops there, or with some ruthless temporary cuts in appropriations and some penny-wise pound-foolish economies. Just now the chief effort of the commission named above is to keep down the New York City budget for 1927, to be acted on Oct. 31. One relatively slight budget increase that would save millions in the long run would be to raise the salaries of professional engineers in the city's employ to a living wage, for men of their education, experience and responsibilities. With vast construction and operating programs in hand the city is so badly underpaying hundreds of engineers that all of them are disheartened and many are leaving the service. This is unjust to the men and costly to the city. If the new commission wants to make the "tax dollar go further," as we do not question, here is one means to that end. The same path lies open in many other cities.

The Backward Swing

ONE of the backward swings of the pendulum so common in the history of an art or a science is now evident in sewage clarification by settlement. It is a return to plain sedimentation, frequently with separate sludge digestion, which in itself is a swing back from the original septic tank. It began with the gradual replacement of chemical precipitation by the one-

story septic tanks or, occasionally, by plain sedimentation; was continued by almost complete replacement of chemical treatments by the two-story tank; and now is hurrying on with the increasing adoption of plain sedimentation tanks of one story, with separate sludge digestion. On a large scale, Birmingham was the British city that led the way in separate digestion, as also Baltimore in this country. Recently a considerable number of small American cities have adopted plain sedimentation with separate sludge digestion. The same is being done by some of the smaller cities of England, as witness the Bath sewage-works, noted on p. 573 of this issue. The extent and significance of these changes is given space and stress in the new book on "Solving Sewage Problems," by George W. Fuller and James R. McClinton, which we expect to notice in our Engineering Literature section next week.

Metropolitan Reclamation

NOWHERE in any metropolitan area is there such an anomaly as the unused Jersey meadows just west of New York City. Here, in the heart of the world's greatest metropolitan district, equidistant but a few miles from the business centers of Manhattan Island and Newark, crossed by good highways and by trunk-line railroads, and reachable by navigable rivers, lie thousands of acres of empty land. With real estate all about it annually pyramiding in value, it remains almost as it was a century ago—all because it lies practically at tidewater and is therefore marshy and, at times, even submerged. Slowly this waste land is being reclaimed, but only piecemeal, when some individual plant, with its piled foundations and localized fills and approaches, is built. The major problem of reclamation has never been tackled, though the engineering therefor is not particularly difficult. Wholesale reclamation does not lie within the power or the province of private enterprise and no public body, either state, county or city, has so far been able to see the economic advantage of such reclamation, or at any rate to see profit enough to warrant the expenditure. The state of New Jersey has considered the problem a number of times without action; its next legislature is to receive a report from the Board of Commerce and Navigation which may lead to some ordered move toward action. Certainly, there should be enough foresight and energy somewhere in the state to prepare a plan for the reclamation of these waste lands.

The Water-Works Picture

THE water-works picture of any country is incomplete without taking into account not only works for municipal supply but also the independent works for the supply of the railways, public utilities, industrial plants, institutions and hotels. In addition, there are private water supplies for isolated houses, each small but each requiring some plant and equipment which when multiplied by millions would run into no small total of pumps, pipe, valves and other supplies. These reflections are suggested by the notes on the water supply of the Illinois Central Railroad (p. 572). In round numbers, it took 16 billion gallons to meet the water-supply needs of that one railway system in 1925. Of that amount, a fourth was bought from municipalities and the remainder supplied by the railway itself. Many pumping stations and water softening plants are operated, as is also true in greater or less degree of the other railway systems of the country, although some may have no softening plants. Water softening has doubtless been carried further by railway and industrial plants than by cities. It might well be and doubtless will be rapidly extended by all within the next few years.

Railroad Orphans

WHAT shall be done with the "short-line railroads"? That question is being asked throughout the country wherever railroad consolidation is discussed. It is being answered in various ways. L. F. Loree, president of the Delaware & Hudson Co. and chairman of the board of the Missouri-Kansas-Texas and of the Kansas City Southern railroads, says with characteristic bluntness, scrap most of them. He figures that some 30,000 miles of branch and short-line railroads are outworn tools operated at an economic loss and should be taken up. He is openly opposed to the alternate proposition to force the trunk line systems to absorb the short-line railroads which connect with them.

The problem is not so simple that it can be correctly solved by either method. The unprofitable short-line and branch railroads fall into two general classes, those built for a legitimate purpose where there was every reason to believe that a railroad would be a paying proposition, and those built as independent promotion schemes, constructed with little thought as to whether they would pay or not. The latter class might well be disposed of as Mr. Loree proposes. Certainly, such roads should not be saddled upon the owners of the connecting railroads when they had nothing to say about their construction. The owners of the larger roads should not be compelled to accept reduced dividends to keep the uneconomic short line running. In such cases, the rights of the owners of the trunk line railroad are superior to those of the property owners along the smaller railroads and as someone's rights have to be sacrificed it must be those of the latter. But in the case of a short line built with legitimate prospects which either have not materialized or which have been offset by the rising cost of labor and material, the situation is different. It may be that the short line, while no longer a paying proposition in itself, still is an artery of traffic which it is desirable to keep open. In such a case, the right of the community is superior to that of the stockholders of the trunk line, and they, as stockholders in a public utility, must stand the loss as a part of their return to the community for the privilege it granted them. Branch lines built by the trunk line itself fall in the same class, but in this case the responsibility of the stockholders of the trunk line is even greater. They built them with the expectation of increasing their profits. Just because the profits fail to materialize they should not be allowed to abandon the lines without compensating those who will suffer from their abandonment.

No fixed rule can be written for so complex a problem, but the fact should not be overlooked that the railroads long ago ceased to be purely private property which the owners can dispose of as they see fit. The public has granted them certain valuable rights and now has legislation to protect them from just the sort of destructive competition which resulted in the construction of some

of the present troublesome short lines. In return, the people expect the owners of the railroads to maintain a complete transportation system, not just those parts of it which are the most profitable. If the taking of important but unproductive short-line railroads into their systems results in a serious reduction in the net return to the owners of the larger systems, then the owners can properly expect to be granted an increase in rates to compensate them for the loss. Both parties to the present arrangement have interlocking responsibilities.

New Light on Wind Action

THE Florida hurricane visitation of two weeks ago displayed the power of the winds more terribly than has occurred in the era of modern construction. For this reason quite as much as for the great destruction of life and property, the experiences of this storm will long be memorable. They promise to make significant additions to human knowledge in the matter of wind action and the resistance of structures. And perhaps this gain will constitute a measurable item of salvage from the tremendous total of destruction.

For the first time a great storm, one that ranks with the most violent ever known, swept through a modern community containing major engineering structures that were built with the aid of all the closely calculating science of present-day technical art. In consequence, we have before us the first measurable evidences of storm-wind force, from which it may be possible to reason how future construction can be made more completely proof against the elements. Both the builder and the structural engineer needed such a trial of great emergency, in order to tell them whether their past efforts to provide strength against storm fury have been effective or the opposite. No such full-scale test of engineering construction has come to pass for many years. Possibly the collapse of the Quebec bridge, nineteen years ago, compares with it, but the unforgettably deep impression of that disaster was due more to its human causation than to the bearing of the accident on man's fuller control of natural agencies; the art of the bridgebuilder had been under test before, on many occasions during a half century of development. But the high building, since its birth in the nineties, has never met a crucial test of its most difficult feature, its resistance to wind pressure; the Florida hurricane brought such a test.

Taken as a whole, the outcome of the test is such as to warrant high satisfaction with the engineering methods employed. The violence of the storm far exceeded that for which definite provision is usually made in design, and Miami's buildings, towers and the like had been planned on the same basis as structures in normal latitudes, in spite of the notorious storm dangers of the nearby Caribbean circle. The Sept. 18 hurricane thus stressed these structures well beyond the limit contemplated in their design, yet they stood secure. The exceptions, which are few and doubtless reflect various special causes, do not modify this general statement. Broadly, then, past practice in the design of engineering structures and provision of safety reserve finds itself vindicated.

This is only a qualitative conclusion, of course. Engineering purposes will require that a specific estimate of the actually exerted pressures be made. The fact that most structures resisted does not mean that we can rest content with the conventional figures of design and are not interested in actual pressures. The failure of a few structures, in fact, is too clear a warning that the wind-resistance problem still contains much difficulty and empiricism. Other structures may have been on the verge of failure, or survived only by virtue of some chance unappreciated element of the assemblage.

Data for estimating actual pressures are not yet available, but they should be found in the design figures of some of the failed and some of the undamaged structures. The two office buildings which were damaged are likely to give the best data. In fact the forward part of the Meyer-Kiser building should supply closely correct wind-pressure figures, for in this particular case it is known that the columns bent under the deflecting force, and their yield-point bending resistance can be computed from their dimensions within a small margin. The figures when known will probably be much higher than the conventional 20 to 25 pounds of design practice. If so, it will doubtless be wise to adopt this higher figure for future design, at least in known storm regions.

But another feature of the Florida storm-wind manifestations is vitally important. The general nature of the wind as observed by those who lived through it, the character of some of the failures, and other facts, go to show that past engineering views of wind pressure have been defective in one respect. Wind pressure has always been treated as static. At Miami it was quite other than static. It shook and pounded the high buildings visibly, as successive gusts hit them. Such a force has dynamic possibilities. Its swaying effects may be important; and there is every likelihood that much of the injury to the damaged high buildings originated in this swaying and would not have occurred under steady pressure. Steady pressure can hardly unlatch windows, move parts of a building or cause turnbuckles to unscrew. If engineering design is to make structures truly stormproof, it should evidently deal with wind as with a dynamic, pulsating force.

Intermittent or pulsating wind force is also suggested by the behavior of tall smokestacks and radio towers as compared with that of more rigid structures such as buildings or elevated tanks. The flexible structures failed, the more rigid structures resisted unharmed, though unquestionably designed for substantially identical wind-pressures. Under mere static pressure they should have shown equal resistance. But under pulsating forces the more flexible structures could sway and whip about in the storm gusts, and so undergo stresses out of proportion to the dead pressure. Rigid structures are proof against such action. In view of these facts, it seems to be necessary to deal with wind pressure rather differently than has been done in the past. Its dynamic character claims attention, with the possibility that its intermittent gusts may set up large oscillations in flexible structures.

As a corollary it follows also that rigidity becomes an important desideratum of design, to secure resistance to wind action. The value of rigidity in many types of structure has long been recognized in a general way, but its bearing on wind resistance has not been clear. Tall and narrow buildings, which have less inherent rigidity than low and broader buildings, may give occasion for special means to increase their rigidity.

New York's Third Subway Under Construction

Variation in Street Conditions and Materials Called for Four Modifications of Timbering Plans All Designed for Power Shovel Excavation and Truck Haulage

By Leo M. Charm
Of Engineering Staff, Rosoff Subway Construction Co., Inc., New York

Continuing a series of articles on rapid-transit subway construction now in progress in New York, where a complete new network of lines is being added to those built in 1900-1904 *and* 1913-1918. *The first article, June* 17, 1926, *p.* 970, *outlined the planning of the new system. Succeeding articles on separate sections of the work have appeared, July* 8, 1926, *p.* 60, *July* 22, 1926, *p.* 142, *Aug.* 5, 1926, *p.* 216, *and Sept.* 9, *p.* 418.

Section 3A of Route 78 of the Eighth Ave.-Washington Heights line on St. Nicholas Ave., between 122nd and 132nd Streets, is 2,640 ft. long. The railway is standard one-level four-track line ("Engineering News-Record," June 17, 1926, p 970), except at the north end where there are two additional tracks for storage. There is an express station at 125th St. On the east side of the street, which is 100 ft. between building lines, there are brick buildings, generally four to six stories, the full length of the section. Similar buildings border the west side of the street from 122nd to 128th Streets. North of 128th St. to 132nd St. on the west is St. Nicholas Park rising in a rocky bluff from street level. The 125th St. station has a mezzanine floor 660x75 to 85 ft. and two island platforms 660 ft. long. At 124th St. a sewer system of three 48-in. cast-iron pipes passes under and is a part of the contract structures.

Construction on this section was begun March 14, 1925, and the work is now 85 per cent complete.—Editor.

POWER-SHOVEL excavation with motor-truck haulage of spoil directly from the cut was laid down as an essential of the construction plan for Section 3A, Route 78 of the third subway system. This in turn called for a timbering system for the cut which would give clear space underneath for shovel and truck operation. Incidentally it dictated ramps instead of shafts for raising the spoil from the excavation.

FIG. 1—BYPASSING 36-IN. AND 24-IN. GAS PIPES OVER ST. NICHOLAS AVE. AT 124th ST.

Briefly the cut required for placing the subway structure was 2,640 ft. long, from 60 to 90 ft. wide and from 25 to 35 ft. deep. These dimensions carried the excavation well up to the buildings generally and in places under them, and always to a depth well below the building foundations. For about 1,800 ft. of the north end of the section rock is at the street surface on the west side and slopes downward to about half the depth of the cut on the east side of the street. The overburden is earth and loose rock. South of this section the cut is in earth, loose rock, rock fill and rock. The excavation quantities are 120,000 cu.yd. solid rock and 150,000 cu.yd. of other materials. The subway structure called for 35,000 cu.yd. of concrete and 5,000 tons of steelwork.

Construction is planned to follow this sequence: (1) Bypassing gas mains; (2) underpinning buildings; (3) opening and covering street half at a time; (4) constructing ramps; (5) excavation; (6) concreting track slab and column footings; (7) erecting steel; (8) concreting walls; (9) roof concreting after load of street structures is transmitted to permanent steel; (10) waterproofing, protective concreting and backfilling; (11) restoring sub-surface street services; (12) repaving. The contract was signed March 5 and work was formally begun March 14, 1925.

Bypassing and Underpinning—Occupation by the subway structure of virtually all of the street made necessary the care of all street structures and services. All buildings had to be underpinned; stoops along both sides of the avenue had to be removed or supported; gas and water pipes had to be relocated; existing sewers replaced by sewer flumes, and electric cables and

FIG. 2—OPEN CUT AND HALF-WIDTH TIMBERING

pneumatic tubes carried. Much of the temporary conduit work was handled in connection with the timbering work and is there indicated. Gas main bypassing was, however, accomplished by surface or overhead

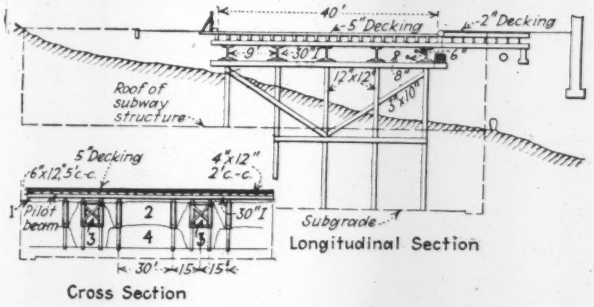


FIG. 3—OPEN CUT AND HALF-WIDTH DECKING ALONG ST. NICHOLAS PARK

lines. This overhead gas bypass work involved some unique structures as indicated by Fig. 1. North of 128th St. three gas mains were replaced by one 12-in.

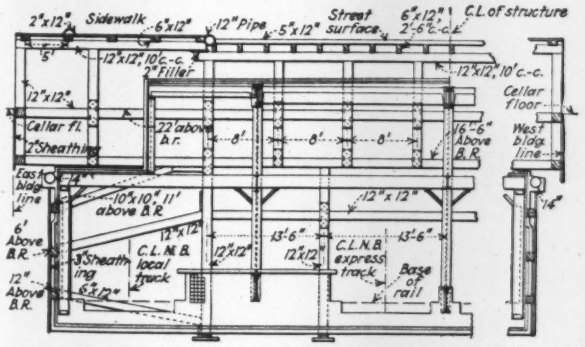


FIG. 4—TIMBERING FOR DEEP AND WIDE CUT FOR EXPRESS STATION

gutter pipe along the east curb line of St. Nicholas Ave. Crossing the avenue were a 48-in. overhead crossing at 127th St.; one 20-in. and one 30-in. overhead crossing at 126th St.; one 12-in. and one 20-in. overhead crossing at 125th St.; one 24-in. and one 36-in. overhead crossing at 124th St. (Fig. 1), and at 123rd St., one 12-in., one 24-in. and one 36-in. overhead crossing. Except to note the amount of this gas bypass construction it is left for consideration in a special article.

As stated, all buildings had to be underpinned. Few of them were of great height but, by the same token, their foundations were not particularly deep or stable. Methods varied with conditions. Generally concrete piers, spanned between by reinforced-concrete beams carrying the walls, were used. In other cases steel cylinders were jacked down and filled with concrete.

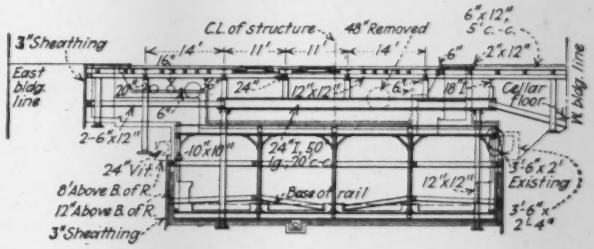


FIG. 5—TIMBERING FOR CUT SOUTH OF 124TH ST.

Where later the foundation load had to be transferred to the subway steel, steel-beam needles were put through the piers to take seat finally on the roof beams of the subway. In general there were no extra-hazardous underpinning tasks nor were special methods required but the standard methods used received unusual care.

Decking and Timbering Cut—Timbering and excavation are supplementary and simultaneous operations in large measure but separate description makes them more easily understood. At the outset, the avenue was

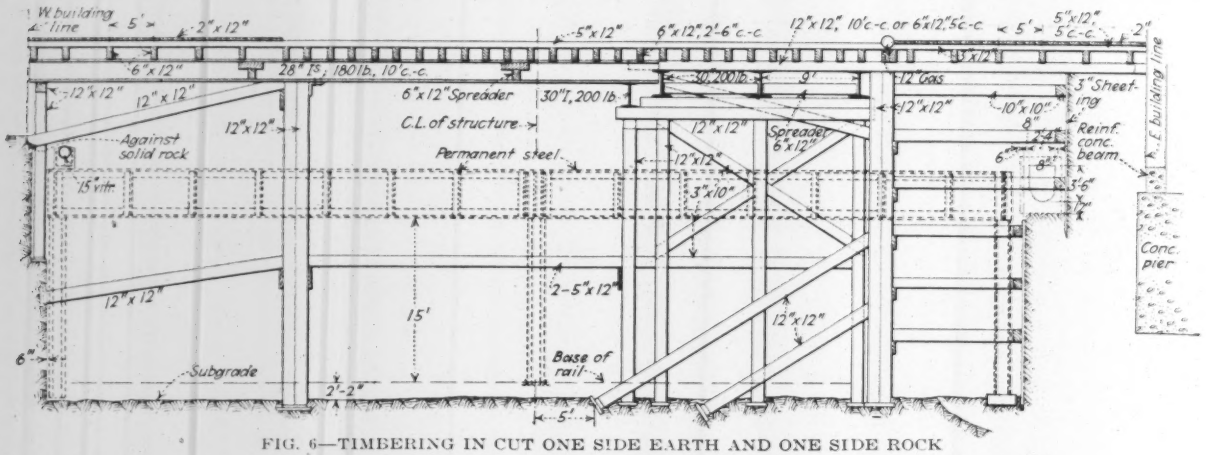


FIG. 6—TIMBERING IN CUT ONE SIDE EARTH AND ONE SIDE ROCK

decked its full width. A power shovel removed the pavement for one-half the street width and excavated deep enough to allow the 30-in. I-beams and 5x12-in. decking supported by 12x12-in. posts to be placed. When one-half of the avenue was covered and available for traffic, the other half was excavated and decked similarly. With the street decked full width, the posts were carried down and the timbering and bracing were developed always with the object of bridging the cut and so far as possible keeping a clear space underneath for power shovels and trucks and for construction operations. As the trench was in places 90 ft. wide and over 30 ft. deep this timbering process was a major one.

A number of types of timbering were used to meet varying situations. While the basic design in all cases was a wide-open structure of longitudinal 30-in. 200-lb. I-beams carrying the timber deck and in turn supported by bents of posts and caps, the requirement had always to be met that the timbering could not interfere with the placement of permanent structure. Again there were varying demands for side support of the cut. How these conditions influenced the timbering design, and yet satisfied the essential requirement of providing room for power shovel and motor truck excavation, are indicated by the following examples of timbering plans.

North of 128th St. where the subway borders St. Nicholas Park one-half only of the street was timbered, the other half being taken out in open cut as indicated by Figs. 2 and 3. The half-width timbering holds closely to the basic design described. South of 128th St. the full width of the street between building lines was decked, the east side of the cut being in earth while the west side was in rock. Fig. 6 shows the timbering system. This arrangement gave, first, a stiff support for the east side of the cut in earth 30 ft. deep and close to the building line, and second, for the west side where the cut was in rock a particularly wide open space for excavating operations. In the section of the 125th St. station between 124th and 126th streets there was no rock, the material being sandy loam and gravel; the depth of excavation was about 34 ft. and

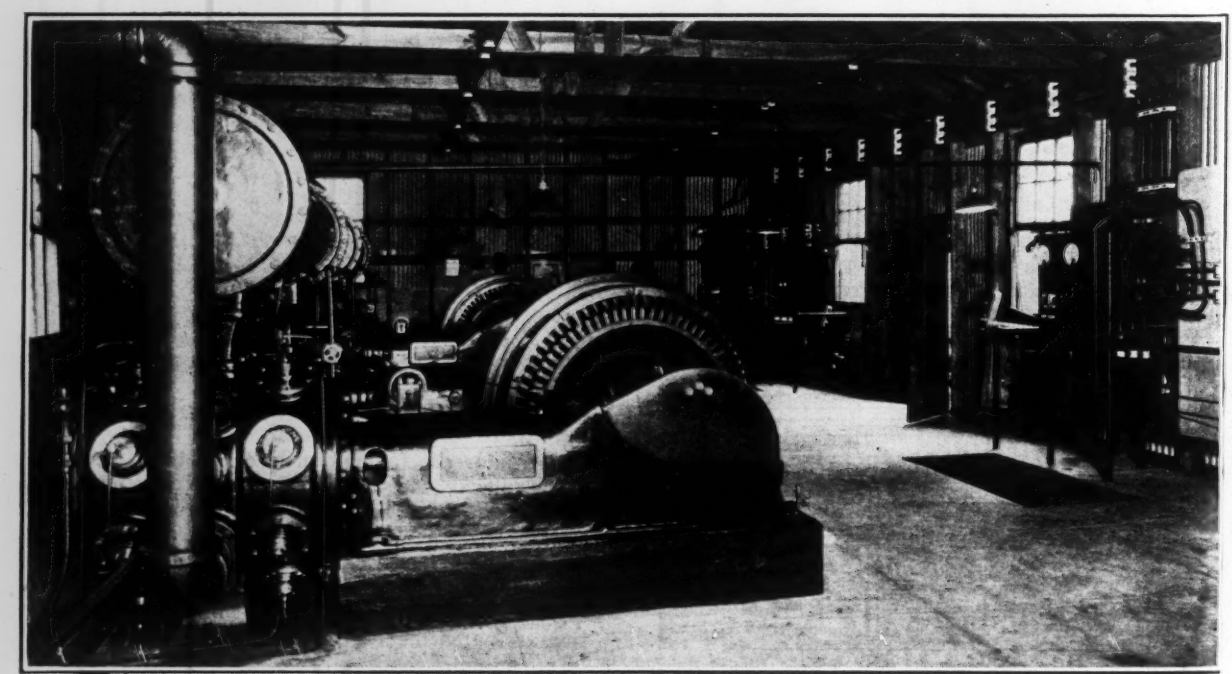


FIG. 7—ELECTRICALLY OPERATED COMPRESSOR PLANT FOR SUBWAY CONSTRUCTION

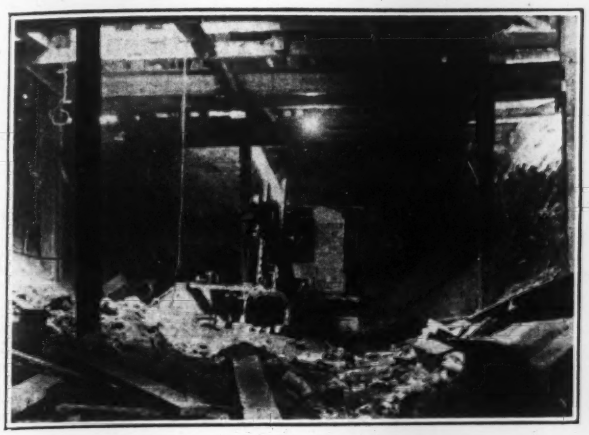


FIG. 8—POWER SHOVEL WORKING UNDER STREET DECKING

the width about 95 ft., the subgrade being 12 ft. below ground water level. On account of these conditions and the proximity of buildings on both sides of the street to the excavation lines it was necessary to use heavy bracing to support the sides, and the method shown in Fig. 4 was adopted. For the section south of 124th St. the decking and bracing system shown by Fig. 5 was employed. A feature of this system is that the floor and steel of the two central bents were first put in and held the bracing and sheeting for excavating for the two outside tracks.

Excavation—Virtually all excavation is by power shovel loading directly into trucks which climb ramps to the street and go on to the dumps. Ramps were used to raise the greater part of the excavation but in one or two cases the shaft method met the conditions better and was used. An example was the six-track section north of 128th St.; the excavation for the east track on account of its being very close to buildings was left until the steel for the other tracks was in place and could be used to brace against when sheeting the side of the cut close to the building line. There were three ramps. Two of these were at 132nd St. and at 129th St. and handled the excavation north of the 125th St. station and some of the station excavation. The third ramp at 123rd St. handled the remainder of the excavation. Fig. 8 shows a shovel at work in the cut at 123rd St. where the timbering shown by Fig. 6 was used.

Blasting was required for about one-half of the excavation. Generally a center cut was made and widened. To trim the sides, line holes 6 to 12 in. apart were fired with small charges. The chief trouble came from slides. These were handled in various ways but generally by buttresses of rock left until the steelwork was in place to hold the cut wall and then taken out. Ground water offered no problem beyond ordinary pumping methods. Compressed air was used for drilling, paving breakers, pumping, steel riveting and other pneumatic tools and was provided by a power plant shown in Fig. 7. This plant consisted of two 250-hp. motor-driven compressors with a combined capacity of 2,600 cu.ft. of free air per minute. The pressure at the compressor was 110 lb.

FIG. 9—STEEL FORMS FOR PARTITION WALL

Steel Erection and Concreting—First the floor and column footings were concreted. Steel erection, center-wall and side-wall concreting followed in order. Steel

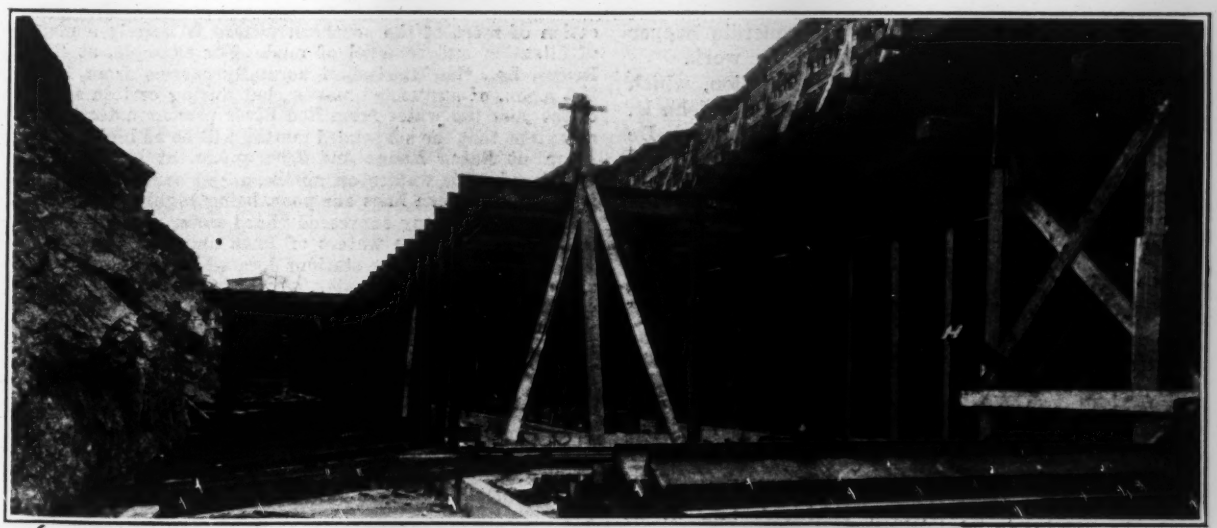


FIG. 10—STEEL ERECTION IN OPEN CUT AND UNDER DECKING

forms were used for center wall and for the side walls above the duct benches. For the roof jack arch forms of steel carried by travelers were used. Waterproofing, protective concreting, backfilling and street restoration follow in sequence. Fig. 9 shows a section of center wall and the steel forms. Fig. 10 shows steelwork in open cut and under the decking north of 128th St.

The concrete was mixed at a central plant at 128th St. and St. Nicholas Ave. where a side hill provided an admirable site for gravity handling of concrete materials and mixed concrete. The design of the plant is shown by Fig. 11. All materials come in by truck at street level on the hill top. Sand and stone are dumped into the mixer bins or into stock piles having capacities of 3,000 cu.yd. of stone and 2,000 cu.yd. of sand. The cement in bags is unloaded from trucks into chutes leading to the cement house floor. From the mixer bins stone is measured into the mixer charging hopper and sand into an inundator and then into the charging hopper. Cement is measured into a hopper over a belt conveyor which runs to the charging hopper.

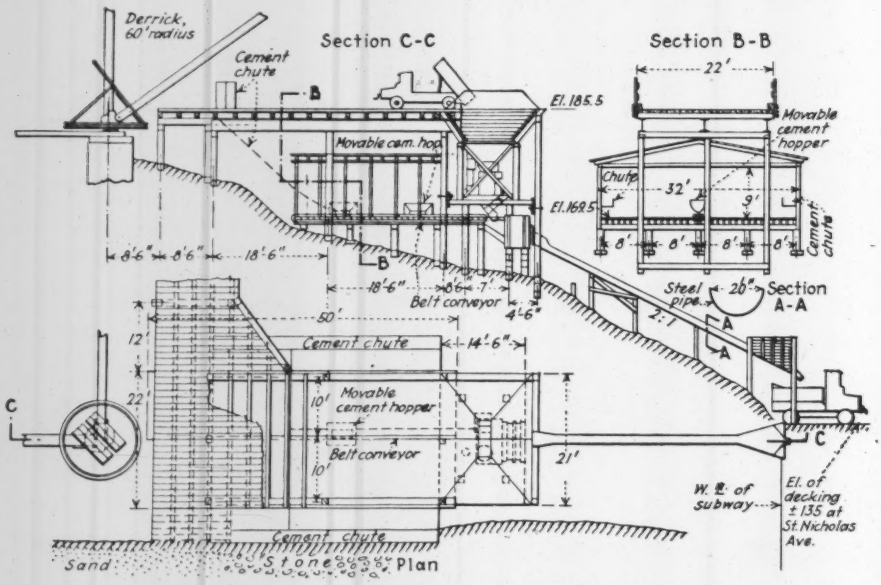


FIG. 11—CONCRETE MIXING PLANT ON NEW YORK SUBWAY JOB

From the mixer a chute runs to the concrete hopper trucks at street level deliver concrete to the work.

Organization—The Board of Transportation, which is constructing this subway system, consists of John H. Delaney, chairman, and D. L. Ryan and William De Ford, commissioners. The work is being designed and supervised by its engineering department, of which Robert Ridgway is chief engineer. Col. J. R. Slattery is deputy chief engineer in charge of construction, and Sverre Dahm is deputy chief engineer in charge of design. J. O. Shipman is engineer of the First Division, John H. Myers of the Second Division, J. B. Snow of the Tunnel Division, H. N. Latey of equipment and operation, R. H. Jacobs of the Track Division, J. T. Kane of the Station Finish Division and A. I. Raisman of the Designs Division.

The constractor for the section being described is the Rosoff Subway Construction Co., S. R. Rosoff, president, Arthur H. Diamant, vice-president, H. C. Sanford, chief engineer, F. W. Stiefel, engineer, and S. L. McLean, superintendent.

Water Supply and Treatment on Illinois Central R.R.

Nearly 16 Billion Gallons Consumed in 1925 of Which 4 Billion Was Bought—Many Softening Plants

BY C. R. KNOWLES
Superintendent of Water Service, Illinois Central System, Chicago

Abstract of a paper read before Illinois Section, A.W.W.A.; printed in Journal A.W.W.A., July, 1926.

ILLINOIS Central R.R. System locomotives ran 56,000,000 miles in 1925, hauling 35,000,000 passengers and 69,000,000 tons of freight, using in excess of 12,000 m.g. of water. In addition, approximately 900 m.g. were required for stationary boilers and approximately 3,000 m.g. for other purposes, making a total of 15,900 m.g. Of this, some 4,000 m.g. were purchased from municipalities, the remainder being pumped by railroad pumping plants.

The supply at 134 points is obtained from wells ranging from 2 to 60 grains hard; that at 144 points is obtained from streams, principally the Mississippi River and its tributaries, but including several fluctuating streams polluted with mine drainage. The water at 14 water stations comes from lakes, at 13 from springs and at 34 stations from reservoirs, thus constituting in all 339 water stations. Of these stations, 99 are supplied with city water and 40 stations are equipped with filtering or softening facilities which range in capacity from 10,000 to 50,000 gal. per hr. [0.24 to 1.2 m.g.d.].

The waters on the southern lines of the Illinois Central R.R. are with few exceptions among the best boiler waters of the country. The exceptions are where the surface waters carry large quantities of mud and other matter in suspension and where the well waters are low in dissolved content and the elements in the water are not properly balanced. To overcome corrosion and pitting from the use of this water it is necessary to add compounds. The purification of most of the southern waters is largely a matter of filtration and removal of mud. For example, at Baton Rouge, La., the Mississippi normally carries from 100 to 350 p.p.m. of suspended matter, but during certain seasons of the year the water from Red River predominates to such an extent that the suspended matter will be as high as 3,300 p.p.m. at Baton Rouge and 2,500 p.p.m. at New Orleans. Compared with waters on northern and southern lines all waters on western lines are poor, being highly mineralized, or as it is commony expressed "hard waters." This is particularly true of the waters of Iowa and northern Illinois.

There are 136 water stations located in Illinois handling annually 6,900 m.g. of water, of which 1,013 m.g. is treated completely with lime and soda ash at 13 water stations and treatment in the form of compound is applied to the water at 15 other stations.

The first water treating plant on the Illinois Central was built in 1900 and at intervals since then other installations have been made, until at the present time there is a total of 34 complete water treating plants in service.

A locomotive could run from Decatur, Ill., to Omaha, Neb. using treated water only, as every station in this stretch of 584 miles is equipped with complete lime and soda water softening plants.

Figures for 1925 show that in treating 1.875 m.g. of

water, ranging from 9 to 56 grains per gallon hardness, the 34 complete lime and soda plants in service, representing an investment of $670,000, removed 3,699,293 lb. of scale forming matter from the water treated. Using the figures of the Water Service committee of the American Railway Engineering Association and after deducting for the cost of operation and maintenance, interest and depreciation on plant, the water softening plants show a net saving of $311,354 per annum, or 46 per cent annual earning on the investment. This saving is limited to the value of reductions effected in the amount of fuel required by locomotives, flue renewals, calking and other running repairs and the time lost by locomotives while under repairs which might be attributed to water conditions.

No figures are available from the standpoint of improved train operation, except, perhaps, the statement that the average performance of locomotives during the past five years has been over 2,000,000 miles per engine failure over the system and more than 5,000,000 miles in treated water territory, a performance considerably greater than that during the period prior to the establishment of water treating facilities by engine districts. The values due to improved locomotive operation, train service, etc., are of an intangible nature. If they were included they would probably equal the direct saving shown above.

The Illinois Central has what is believed to be the oldest water service department of any railroad, organized thirty-five years ago. It is headed by a superintendent of water service reporting jointly to the chief engineer and engineer maintenance of way. Aside from the chief clerk and office force there are two inspectors on the staff.

Separate Sludge Digestion Tanks at Bath, England

SEPARATE sludge digestion, with both primary and secondary digestion tanks, is giving satisfactory results at Bath, England, according to a paper by F. P. Sissons, city engineer, presented to the Royal Sanitary Institute Congress and printed in the London *Surveyor* of July 23. The sludge for treatment is drawn daily from each of six Dortmund tanks with a combined capacity of 1.8 U.S. m.g.d.—installed in 1914 for chemical precipitation, which proved to be unsuited to the sewage of Bath so the tanks are used for plain sedimentation. The effluent passes through sprinkling filters, humus tanks, and then to the River Avon.

The sludge from the Dortmund tanks proved difficult to handle and gave rise to bad odors. After various experimental methods had proved unsuccessful, sludge digestion was adopted on the advice of F. R. O'Shaughnessy of Birmingham. The digestion tank was designed by David Edwards, then city engineer of Bath and now borough engineer of Brighton. The final sludge from the tanks goes to "ash drying beds having an area of ¼ sq.yd. per head of contributing population," now being increased to a ⅓ basis. The primary digestion tanks have a capacity of 2,200 long tons of wet sludge, and the secondary digestion tanks a capacity of 2,000 long tons. The primary tanks are in two units of equal size and the secondary tanks of nine units of equal size.

In operation, fresh sludge from the Dortmund tanks is pumped directly to one of the primary tanks, continuing until that tank is filled, when a shift is made to the second primary tank. When the latter is nearly full, the contents of the first primary tank is pumped to one of the nine secondary tanks, these being filled in sequence. Two feet of sludge is always left in the digestion tanks for seeding purposes. When the water and sludge in the primary tanks separate, as they do in warmer weather, the separated water is pumped to the secondary tanks; but the separated water from the secondary tanks is returned to the raw sewage entering the Dortmund tanks. Sludge from the humus tanks, which receive the filter effluent, is passed through the digestion tanks "without detriment to the working of the scheme." Provision is made for raising the temperature of the sludge in cold weather by adding steam, but this has not been found necessary thus far, "the sludge being sufficiently active in its natural state for the [digestion] process to be continuous."

The digestion tanks were installed in 1922 and 1923. Before being put in use, sludge was allowed to accumulate in two of the Dortmund tanks until it amounted to about 200 long tons. The accumulated sludge was then allowed to ripen, sewage being added daily. The ripened sludge was pumped to the primary tanks and the operation of both sets of tanks started. The digested sludge is kept on the drying beds for from four to six weeks when, "except in very dry weather in the autumn and winter," it is "so dry that it has the appearance of a porous cake of soil."

Up to March, 1926, some 66,000 long tons of sludge had been pumped from the Dortmund tanks to the digestion tanks and there treated, with an approximate removal of 30,000 long tons of water, or nearly 46 per cent. Mr. Sissons states that "the dry sludge is easily handled, and is finding a ready disposal to farmers for manure purposes." He gives the following analysis of dry sludge from the drying beds.

	Per Cent	
Nitrogen	1.54	
Equals ammonia	1.87	
Potash (K_2O)	.02	
Calcium phosphate	2.34	
Phosphate citric, soluble	1.84	
		8.29
Mineral matter		45.9
Organic matter		45.81
Total		100.00

The cost of the installation was £10,000 ($48,650) but this does not include the cost of the primary digestion tanks which were constructed originally and used for some time to receive storm water.

Milwaukee Limits Building Heights

Under a Wisconsin home-rule enabling act, the city of Milwaukee in April passed a charter ordinance "electing" that the state law regulating the height of buildings shall not apply to that city. This ordinance permits a building height of 250 ft. and the attorney-general contested the matter in the courts. The State Supreme Court at first decided that this ordinance was illegal, but later reconsidered its action and approved of the city's ordinance. Under this ordinance, in the 125-ft. district already designated no structure may be erected whose cubical content exceeds the area of the lot multiplied by 125. Application for permits for structures more than 125 ft. high must contain an agreement that the owner considers the site as a single lot within the meaning of the zoning ordinance. Inner courts not opening upon streets, alleys or yards are included in the cubical content. The ordinance does not prevent the erection of a tower for ornamental purposes upon a business building, up to the limit prescribed, providing that the maximum cross-section of the tower does not exceed 25 per cent of the cross-section area of the building and is not closer than 25 ft. to any lot line that is not also a street line. The maximum height to which any building or structure may be erected is 250 ft., measured from grade at the main entrance to the highest point of the building.

Compact Plant Arrangement for Building Foundation

Street-Traffic Crowds Construction Plant Onto Trestles and Under Sidewalk Inside Building Area

A COMPACT arrangement plant for a large foundation job is being used by the contractor for the Savoy-Plaza Hotel, New York City, where 105 circular and rectangular piers are being founded, mostly on pneumatic caissons. The contractor's fundamental aim was to place enough derricks on the site to put down simultaneously a majority of the piers. Tying in with the derrick arrangement were spoil hoppers erected on trestles within the building area and placed for a minimum number of boom swings by the derricks handling the mucked material. The concrete plant, also erected on a trestle, chuted concrete into buckets at suitable points for derrick handling. Finally, the 3,660-cu.ft. compressor plant was located under the sidewalk and outside of the foundation proper.

The building site is 200x150 ft., fronting on Fifth Ave. and extending from 58th to 59th Street. Heavy traffic on Fifth Ave. and 59th St. permitted no obstruction by material piles and truck loading operations, either in the street or on the sidewalk. Trestles carrying the plant units were adopted as the solution. However, permission was obtained from the city to use 6 ft. beyond the curb and all of the sidewalk in 58th St. for material storage.

The first task was the removal of the old walls and footings. Beneath the masonry footings of the columns was a mat 10 ft. thick, consisting of 6 ft. of rubble masonry, many of the stones of derrick size, and 4 ft. of concrete, the whole spreading over probably half of the site. The new piers penetrated this mat to solid rock, which varied from 30 to 50 ft. below the top of the mat, which was in turn 22 ft. below the curb. Since many of the piers are only 2 and 3 ft. between edges practically all of this mat had to be removed. This was done by blasting, using mats and light charges. The masonry was loaded into buckets by hand, hoisted by the derricks to trucks on the trestle platforms and disposed of in filling operations on Long Island. In all, about 10,000 cu.yd. of masonry was removed.

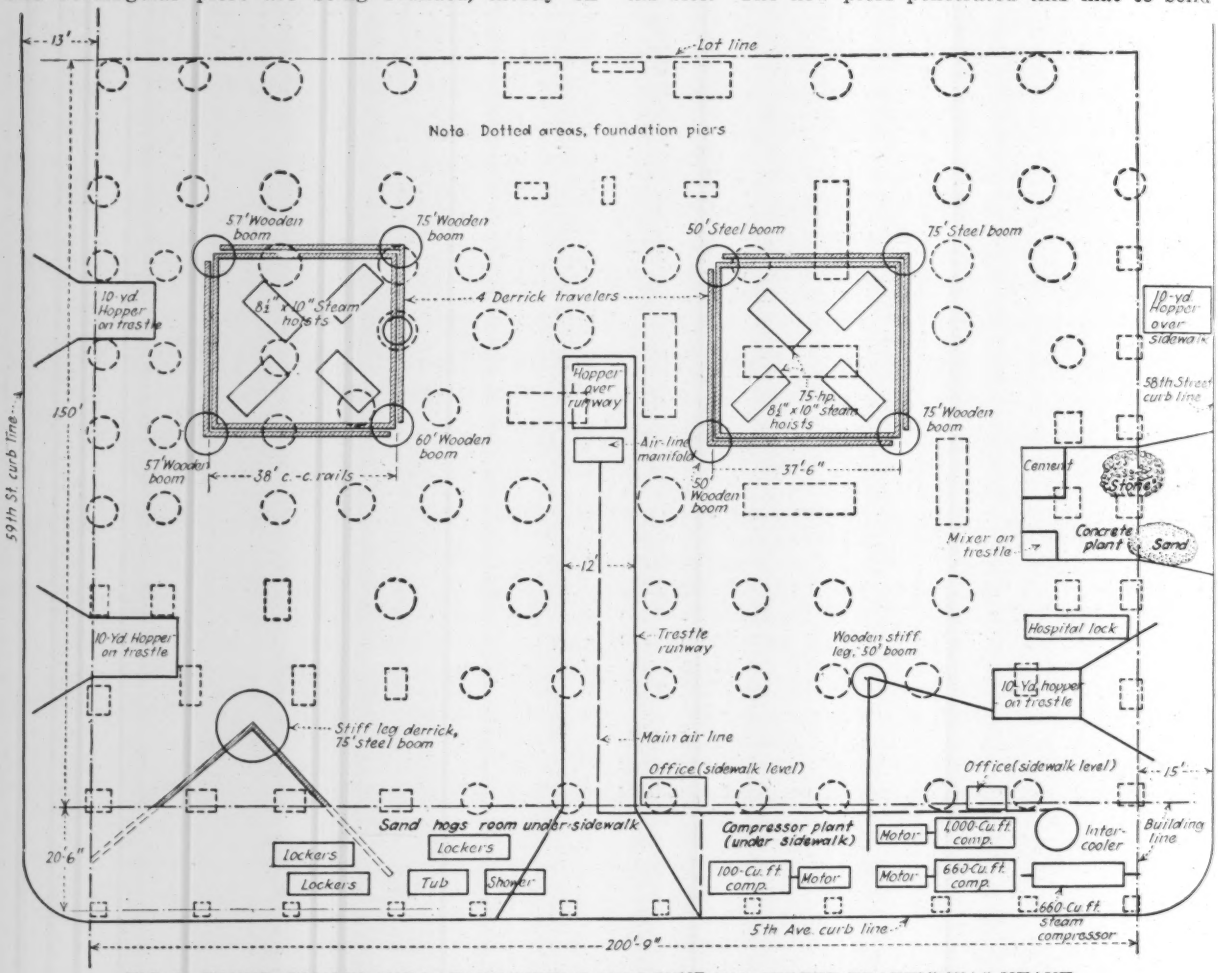


FIG. 1—FOUNDATION PLANT LAYOUT WHERE SURROUNDING STREET TRAFFIC WAS HEAVY

The travelers worked from the back to the front of the site. Spoil hoppers, stiff-leg derricks, and mixing plant were placed on trestles at the street level. Offices were supported on steel I-beams cantilevered over the excavation. Compressor plant and sand hogs' rooms located beneath Fifth Ave. sidewalk.

Type and Arrangement of Plant Units—Two travelers about 40 ft. square, carrying a derrick at each corner operated by a 75-hp. 8½x10-in. steam hoist, started at the back of the site, and worked toward

Fifth Ave. The traveler tracks were placed on the cellar floor. The length of each derrick boom is given in Fig. 1. In addition to these derricks two stiff-legs also operated by 75-hp. steam hoists, were placed on trestles near the front corners of the site, in order to work some of the piers that the derrick booms of the travelers would not reach from their first position. Each derrick performed practically the same operations, namely, removed material from the pier excavations, placed the concrete, and did the necessary shifting of forms, material and air locks.

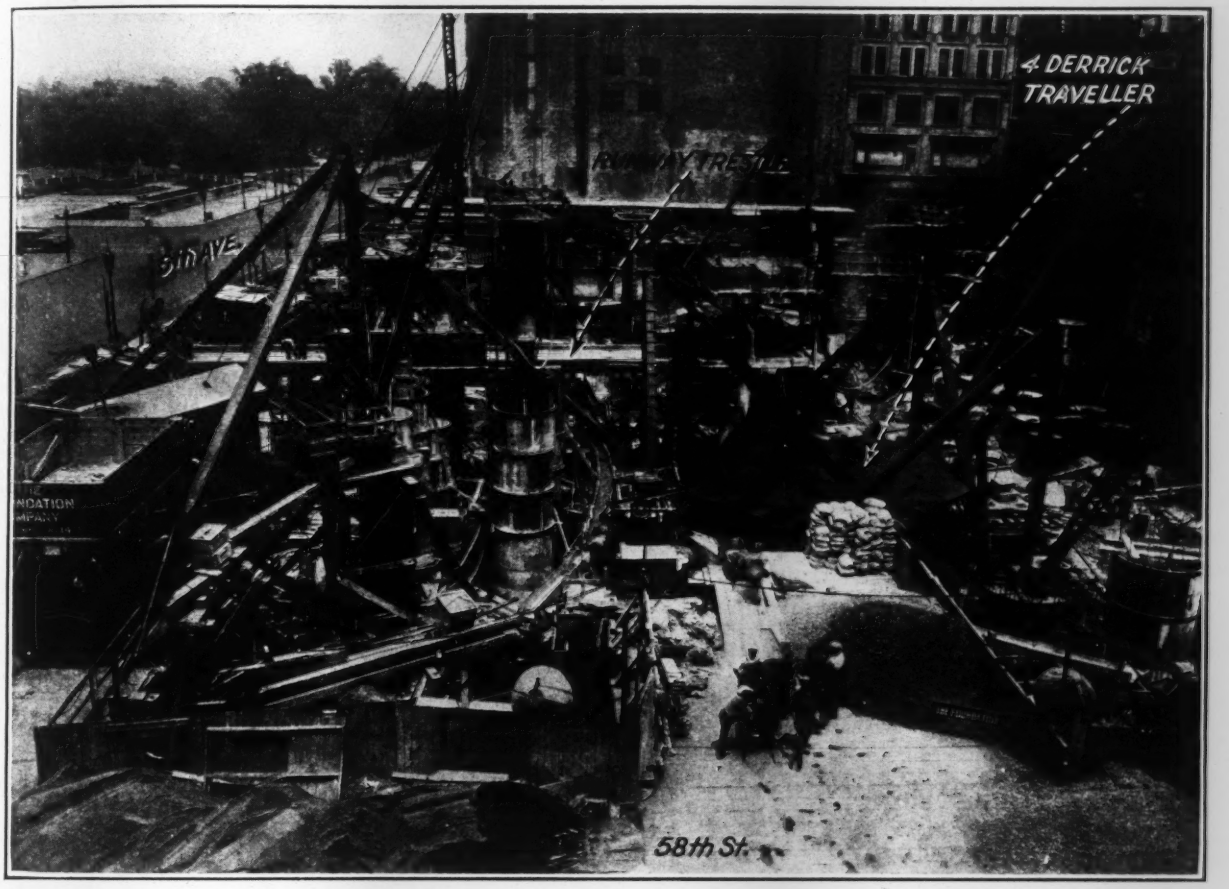


FIG. 2—FOUNDATION CONSTRUCTION PLANT, SAVOY-PLAZA HOTEL, NEW YORK CITY

Excavation progress was kept independent of truck movement by the use of 10-cu.yd. timber hoppers. These were placed as indicated on Fig. 1 and so arranged that a minimum amount of swinging was necessary by any one derrick, in order to reach them. The hoppers were erected on the ends of runways supported by trestles at street level. Thus all truck loading was accomplished within the site and with a minimum of street congestion.

The concreting plant also placed on a platform at street level is shown in the foreground in Fig. 2 and on Fig. 1. The trestle was made large enough to permit trucks to back onto it and dump sand, stone and cement in convenient piles. Wheelbarrow charging was used and wooden chutes radiating in different directions carried the concrete to the cellar floor, where it was discharged into bottom-dump buckets. These buckets were then handled to the piers by the derricks.

The compressor plant and the sand hogs' locker room were placed under the Fifth Ave. sidewalk. This space was formerly a part of the cellar of the old buildings, seemingly having been an engine or boiler room of some sort. It made an ideal compressor plant site, being unusually large, yet entirely out of the way of construction operations and street traffic. Four compressors were used, three being driven by electric motors. The fourth was a self-contained steam machine. Two of the electric machines and the steam machine had an output of 1,000 cu.ft. of free air per minute each; this air was at low pressure for use in the locks. The other electric machine delivered 660 cu.ft. per minute of high-pressure air for drilling both inside and outside the locks.

All air from the compressors passed through an intercooler, also located in the compressor room, from which a 6-in. main led to the center of the foundation site, as shown by Fig. 1. At the end of the line a large manifold was installed, from which the air lines to the various pier operations diverged. By this arrangement a single watchman could be left in charge of all of the piers over Sunday when operations were closed down. Gages on each of the air lines indicated what pressures were being maintained in the different locks.

The contractor's office buildings were placed on the

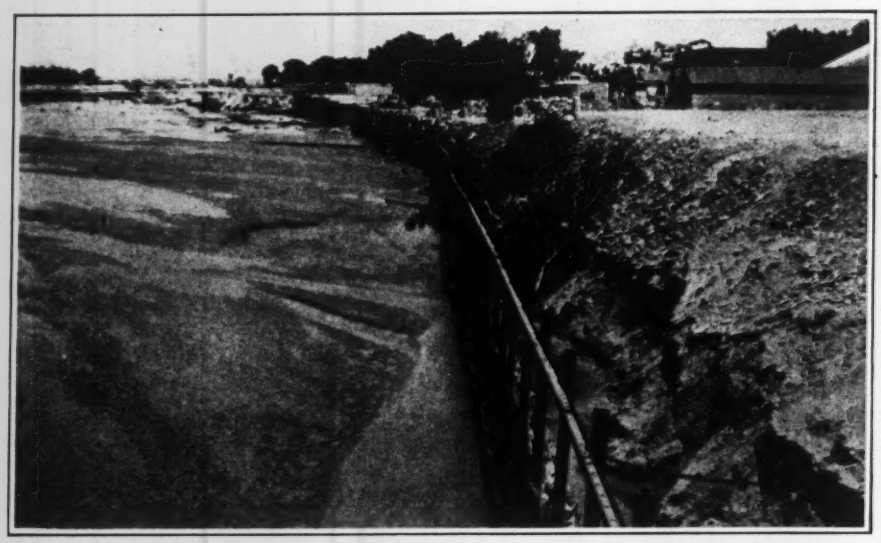
Fifth Ave. building line, and cantilevered over the excavation on some of the floorbeams of the old buildings. A hospital lock, indicated in Fig. 1, was provided. Finally since construction operations were carried on continuously, an elaborate system of flood lighting was used, the lights consisting of 48-in. dishpan reflectors, and 1,000-watt bulbs covered with diffused-light outer globes placed at about 50-ft. intervals entirely around the site. Direct current was used at 220 volts, the incoming bus bars, fuses and terminals being located in a narrow locker on the Fifth Ave. curb.

This plant layout was used by the Foundation Co., New York City, with H. W. Hanning as its superintendent of construction.

Brush, Wire Mesh and Old Rails Make River Retards

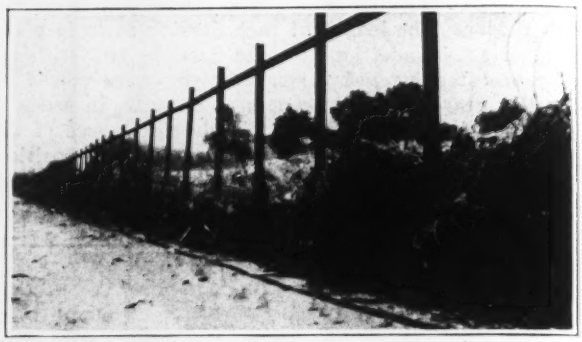
Channel of River in Pueblo, Colo., Restored—Bank Caving Reduced—Protection of Bridge Piers a Feature

OLD 60-lb. rails driven into shale and covered with heavy woven fence wire backed up by brush have been used as retards to build up the caving bank of Fountain River in Pueblo, Colo. The river has a slope of about 25 ft. per mile. The bed is composed of coarse sand formed from disintegrated granite of the Pikes Peak region underlain by a hard shale. In times of floods, which are usually caused by local cloudbursts and last only an hour or two, the velocities are very high and the bottom scours deeply, sometimes down to the rock, the whole bottom of the river becoming a stream of flowing sand. In the past several bridges not founded on rock have been undermined and now all bridge piers are carried to rock. The railroad along the river bank is protected by heavy riprap, many of the pieces being more than a cubic yard in volume.



FENCE EXPOSED TO SEVERE CURRENT AT LOW-WATER STAGES
Ties run to deadman from upper rail. A strip of wire mesh was laid on the flat behind the rails and fastened to the vertical portions so that it would settle down into the undercut portion.

The mesh and the brush of the retards reduce the velocity about one-half and have caused more than 3 ft. of silt to deposit behind the retards, which extend from Fourth St. to Fifteenth St. This has been supplemented by dumping a great deal of earth behind the fences to reclaim part of the land. The retard from Tenth St. to Fifteenth St. was not backed up with brush, as experience with the first section built seemed to indicate that brush was unnecessary and it soon dried out and rotted, making an undesirable fire risk. Furthermore, less obstruction to the flow permitted more of the silt-laden water to pass the retards behind which it dropped its burden. The first freshet (Fountain River is ordinarily dry) deposited about 1½ ft. of silt and demonstrated that the brush was not essential.



RETARDS MADE OF OLD RAILS, BRUSH AND WIRE MESH
The wire mesh was woven on alternate sides of the vertical rails.

The upright rails of the retards are driven 6 ft. apart to rock 12 to 16 ft. below the river bed and the tops are cut off to grade at 12 ft. above the river bed. Rails do not have a tendency to float as do piles nor are they as likely to be undermined because of the smaller surface presented to the current. To stiffen the line a longitudinal rail is bolted on to the upright rails 15 in. below the top, and ¾-in. diagonal rods extending from the lower part of one rail to the top of the second rail downstream are added at intervals. A tie to a deadman in the bank is used at every fourth rail. The wire mesh, 6 ft. wide, is woven front and back of each succeeding rail and wired to prevent its slipping down. In addition to this vertical strip of fencing another strip is laid on the bottom behind the rails but fastened only to the vertical portion. This was done with the expectation that if the current cut under the vertical wire mesh the horizontal portion would settle down and prevent further cutting.

Low cross levees were thrown up about 200 ft. apart to form pools to trap as much silt as possible.

The first retards were constructed in 1922, the contractor driving the rails from a piledriver mounted on a truck. The cost ranged from $2.50 to $3 per lineal foot. The contract price was 19c. per foot of rail for

driving and 35c. per linear foot for stretching and tying the wire. The contractor is said to have made a fair profit.

The work was carried out under the direction of Barton M. Jones, resident engineer for the Dayton-Morgan Engineering Co., for the Pueblo Conservancy District.

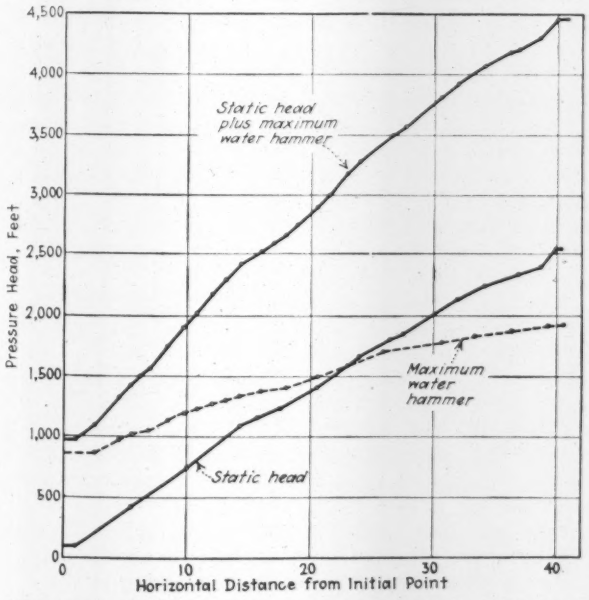
CROSS LEVEES THROWN UP AT INTERVALS TO POND THE SILT-LADEN WATER

Openings were left in the fence to permit access of teams hauling sand from the river bed.

Water Hammer Not So Important Under Highest Heads

On Account of High Initial Pressure Increase Due to Hammer Is Small in Proportion and Within Safe Limits

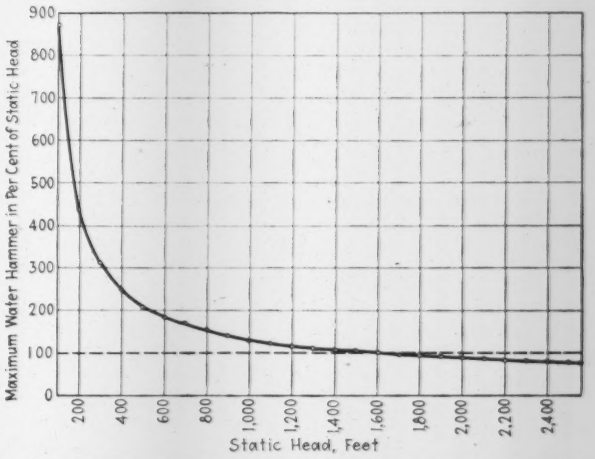
IN THE design of the heavy pipe being used in the lower portion of high-head penstocks, little account is taken of the danger of water hammer. In fact, in the design of one of the three plants with heads exceeding 2,300 ft. which are now under way in California, water hammer in the lower part of the penstock was ignored altogether because maximum possible shock due to this cause under the worst possible conditions could not stress the material beyond elastic limits.



PRESSURE HEAD DIAGRAM, BUCK'S CREEK PENSTOCK

According to Joukovsky's formula the maximum additional pressure that may be imposed on a penstock by water hammer, assuming that the water column is stopped instantly while in full flow, is aV_o/g, where a equals the velocity of a pressure wave in a confined column (3,000 to 4,000 ft. per sec.), V_o is the velocity of water in the penstock under full load (15 to 20 ft. per sec. as a maximum) and g equals the acceleration of gravity, 32.2. In a pipe under 2,500-ft. head this is less than a 100 per cent pressure rise and remembering that there is a safety factor of at least 2 between the working stress and the elastic limit of the pipe metal and that instantaneous closure is impossible in practice, there is no occasion to provide additional pipe thickness on account of danger of water hammer.

This is in strong contrast, on the other hand, to the danger from water hammer in the low-head plant. When the excess pressures that may, theoretically, be impressed on a pipe line get far above 100 per cent of the static head there is need for particular care in controlling or safeguarding against them. In other words, passing down the scale from the highest head plants to heads of say 1,000 ft., if the Joukovsky formula be accepted, special attention to water-hammer danger is warranted because these heads may, theoretically, be subject to a shock materially exceeding a 100 per cent overload of the static head. The maximum water hammer increases as the head decreases, so that in a penstock under 200-ft. head the maximum water hammer, theoretically, may be 400 to 500 per cent of the static head, and under a 100-ft. head may be perhaps 900 per cent of the static head.



RELATION BETWEEN MAXIMUM WATER HAMMER AND STATIC HEAD, BUCK'S CREEK PENSTOCK

Fortunately in these lower head plant standpipes, lower penstock velocities and other factors tend to reduce the risk but the theoretical relation of water hammer to static head still holds and is of value in making analyses of results that might be expected under various operating conditions.

After working out the maximum possible pressure rise due to water hammer in the penstock for the Buck's Creek plant of the Feather River Power Co. in California the results were plotted to show graphically the relation of water hammer to static head, and these relations are shown in the accompanying diagram.

Bridging the Delaware River at Philadelphia—Part II

Three Grades of Steel Used in the Superstructure—Choice of Loading—Features of Design Calculations—Tests Made to Verify Design—Construction of Towers, Cable Spinning, and Suspended Structures

Second Half of Article: Part I Appeared in Engineering News-Record, September 30, p. 530

THE PLANNING, design, and some of the construction features of the Philadelphia-Camden bridge over the Delaware River, which is the largest suspension bridge yet built, were described in Part I, Sept. 30. This second section continues the discussion of design and construction.

Materials—Three grades of structural steel were utilized in the superstructure: Silicon steel for the main compression material of the tower posts, the web members and lateral system of the stiffening trusses, and some of the heavy girders in the approaches; nickel steel for the chords of the stiffening trusses, and medium structural steel for all other structural parts. The reasons for using the two special steels were either economy in weight (as in the webs of the stiffening trusses) or desire to secure great flexibility within the elastic limit of the material (in the towers, and still more so in the truss chords). However, as the differential for silicon steel over carbon steel was usually less than 1c. a pound, and that for nickel steel over silicon steel about 1c., there was distinct economy in the use of these high-strength materials under the unit stresses which the engineers considered suited to them for the particular uses in hand, and the carbon steel was economical only where the special steels would have resulted in thicknesses under the minimum desirable.

Loading—As already mentioned, the deck accommodations adopted by the engineers comprise a six-lane roadway 57 ft. wide, four standard-gage railway tracks (two for rapid transit and two for surface-car service), and two 10-ft. footwalks. Maximum loadings for these several traffic elements totaled 12,000 lb. per lineal foot of bridge, composed of two rapid transit trains at 2,000, two surface-car trains at 1,500, 70 lb. per square foot of roadway, and 50 lb. per square foot of footway. The roadway loading 4,000 lb. per lineal foot of bridge was found to be one-fourth heavier than the average of present roadway loads, and was considered to be sufficient to cover future increase of loading and concentrations under extraordinary conditions. The sum of the units, 12,000 lb. per lineal foot of bridge, represents continuous maximum loading on all of the deck facilities simultaneously; as this is a virtually impossible condition, the amount was regarded as a congested load, to be provided for at extra high stresses, and the working design load was taken at one-half the congested load, or 6,000 lb. per lineal foot, to which ordinary unit stresses were applied.

The weight of the suspended structure is about 26,000 lb. per lineal foot in the main span and 27,000 lb. in the side spans. Live-load was combined with these weights, with temperature variations of 55 deg. F. above or below closing, and in special cases with subnormal dead-load on part of the bridge, as when pavement repairs are going on. Wind pressure was taken at 50 lb. per square foot on the towers, and 30 lb. on the stiffening trusses, counting 1½ times the elevation in both cases. In designing the towers, to provide for all conceivable contingencies and to give extra strength and rigidity in the transverse bracing between posts, the assumption was made that a lateral force of 1,000,000 lb. in addition to wind reactions might be applied to the tower top, as from the impact of an airship. Of the wind load on the suspended roadway and trusses, 1,350 lb. per lineal foot, part is resisted by the cables due to their sharing in the transverse deflection (350 lb. in the main span and 50 lb. in the side span) while the remainder goes through the truss laterals. No impact allowance was figured anywhere except in the form of the 1,000,000-lb. special lateral load at tower top, and in a 50 per cent impact allowance in proportioning the floor slab.

Some Elements of the Calculations—For calculation of the relative action of towers and cables the modulus of elasticity of the cables was taken at 27,000,000 and that of the towers at 29,500,000 lb. per square inch. With these data, and with the various maximum distributions of load and a preliminary design of structure, the equilibrium of main and side spans was investigated, to determine tower deflection. It was found that the range of movement of the tower top for extreme positions of the working load would be 25 in., the range for congested load 39 in., and the extreme range, with subnormal dead-load, 44 in. The maximum horizontal pull in one cable was found to be 35,600,000 lb., and the total vertical load on one tower (both posts) 35,000 tons. These were the initial data in the design.

Under these various forces, the curve of the deflected tower was calculated, beginning with an assumed profile and section and working by trial and error, and from this the direct stresses and the bending stress due to longitudinal deflection of the tower were calculated. Secondary stresses in the tower due to bracing and portal action were well below 5,000 lb. per square inch. For dead-load, congested load, wind and temperature, in worst combinations, the sum of axial and bending stresses was held below 24,000 lb. per square inch, and the total, including secondary stress, below 27,000 lb. per square inch. This is for silicon steel.

For the cables, with a required minimum yield-point of 144,000 lb. per square inch of wire, the maximum allowable combined stress was set at 72,000 lb. Each cable contains 562 sq.in. of steel, and the maximum cable stress for extreme loading is 40,110,000 lb. (71,500 lb. per square inch; under working load 60,800 lb.). Secondary stress due to bending of the cables (mainly near the towers, where angular changes approaching 1 deg. may occur under extreme conditions) and inequalities of stress distribution through the cable are taken as being allowed for by the margin between wire strength and allowed working stress.

In connection with the cables, the design and con-

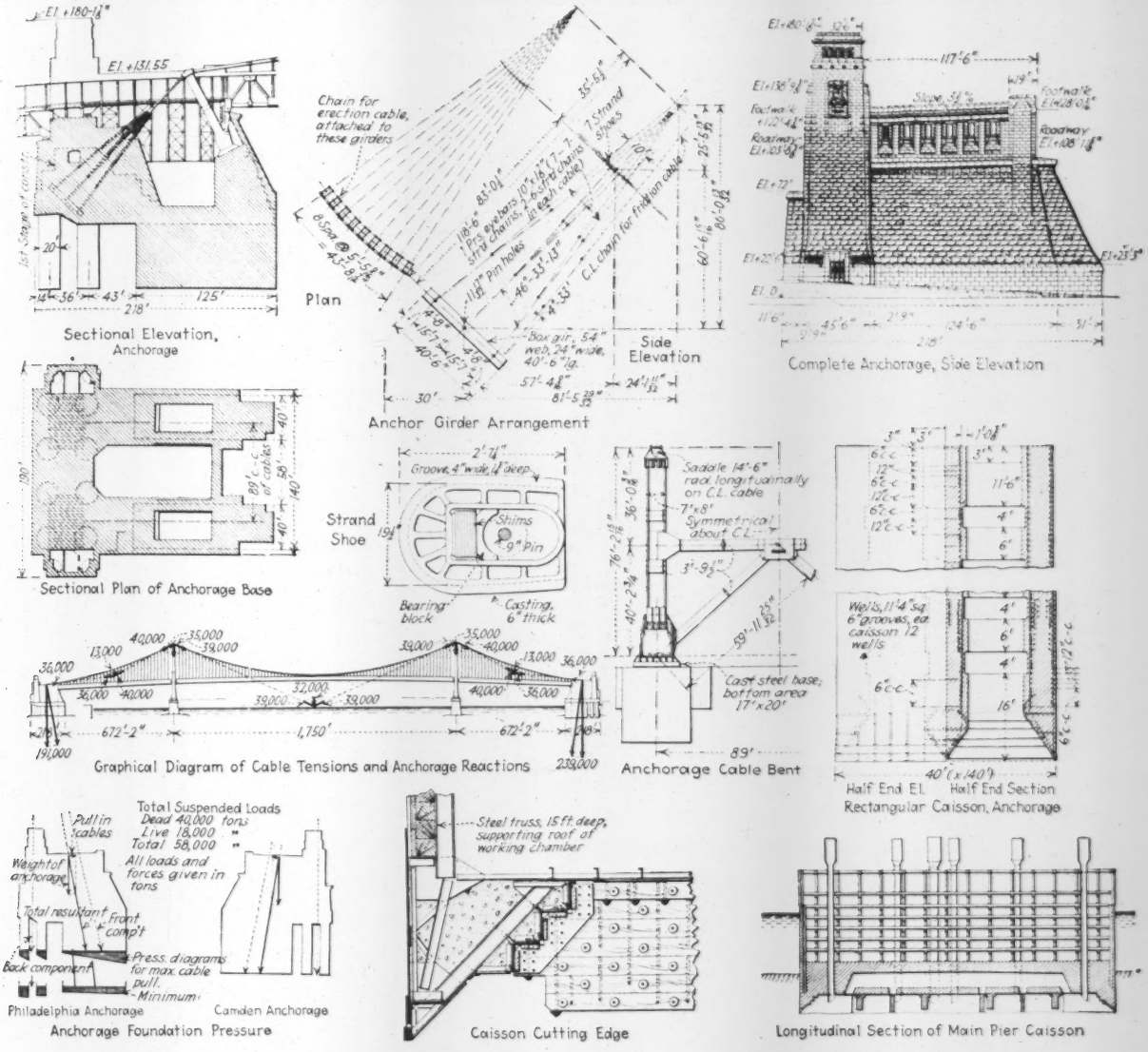


FIG. 10—ANCHORAGE AND CAISSON AND CABLE WORK DETAILS, PHILADELPHIA-CAMDEN BRIDGE

struction details of the cable bands were important, as on some previous bridges it was known that cable bands had slipped downward along the cable and necessitated difficult repair operations. The solution was found in finishing the bore of the cable bands with a slightly rough cut ($\frac{1}{16}$ in. feed, using a roughing tool), fixing their diameter accurately to match the previously determined diameter of the compacted cable, providing cable-band bolts of adequate strength, and tightening these bolts to a definite tension or under a definitely known wrench pull.

The anchorage bents over which the cables passed downward to their sockets presented problems quite like those of the towers and were dealt with in similar manner. With only 76 ft. of length as against the 343 ft. of the tower, and with about two-thirds of the load per post, these bents nevertheless are subject to a $\frac{1}{2}$-in. bending under live-load, and therefore, like the towers, were built of silicon steel. The limited width available for each of these columns argued against the use of a masonry support (such as used in the Manhattan Bridge), since this would have been less safe than a steel post in case of chance transverse impact.

Because of the normal distributed character of highway traffic and the esthetic advantage of a shallow as compared with a deep stiffening truss, only a moderate degree of stiffening action was aimed at. The great weight of cables, trusses and floor, moreover, was available to resist local distortion. But since relatively large stiffening truss movements may occur under extreme conditions of loading it was desirable to use a material of high elastic limit. A steel of 55,000 minimum elastic limit was therefore specified for the truss chords, and under this specification a 3.2 per cent nickel steel was furnished. The working stress allowed in the chords is 40,000 lb. per square inch in tension and 35,000 lb. in compression. In the top chord the unit stress was reduced 3,000 lb. on account of the lateral deflection introduced by the bracketing of the sidewalk and the omission of overhead bracing. The web members were made of silicon steel, and in these 32,000 lb. was allowed in tension and 32,000 — 140 l/r in compression. The

laterals, also of silicon steel, were proportioned for 32,000 in tension and 30,000 — 100 l/r in compression, but something over 10,000 of this is absorbed by participation in chord stress.

The calculations of the stiffening system were carried out by the deflection method instead of the older "elastic method." It is reported by the engineers that this method showed lower truss stress by about one-fourth, and thereby saved some 3,000 tons of steel in the trusses alone, or, when tower and anchorage savings are included, nearly a million dollars of cost.

Verification Tests—A number of significant experimental studies were made in the course of the design, as a check on certain of the engineering conclusions.

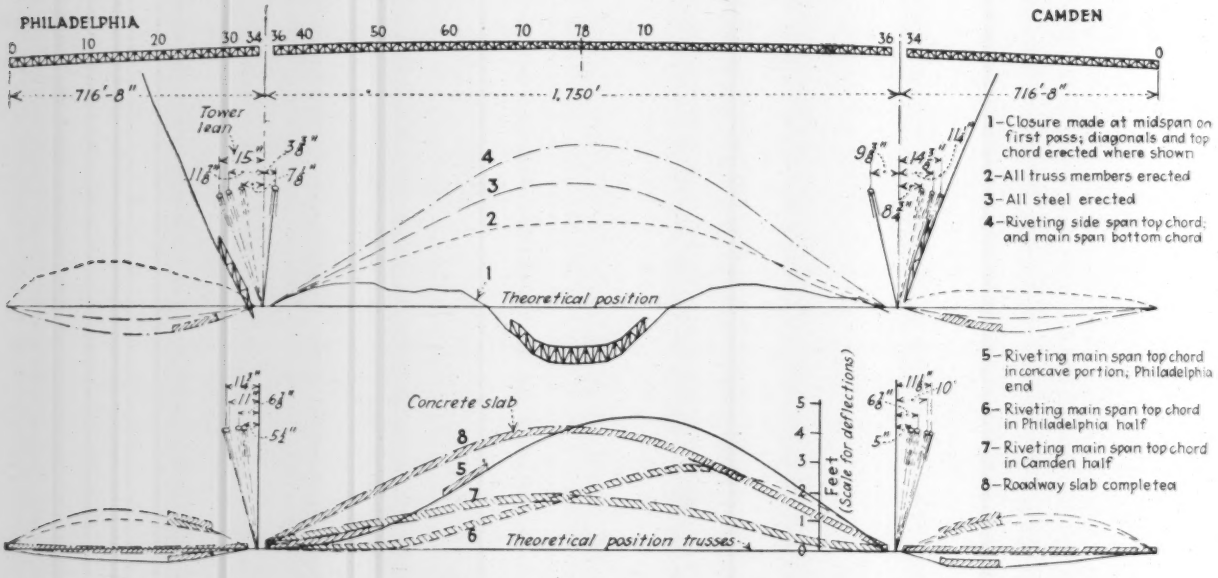

PHILADELPHIA
CAMDEN
716'-8"
1,750'
716'-8"
Tower lean
1-Closure made at midspan on first pass; diagonals and top chord erected where shown
2-All truss members erected
3-All steel erected
4-Riveting side span top chord; and main span bottom chord
Theoretical position
Concrete slab
5-Riveting main span top chord in concave portion, Philadelphia end
6-Riveting main span top chord in Philadelphia half
7-Riveting main span top chord in Camden half
8-Roadway slab completed
Feet (Scale for deflections)
Theoretical position trusses

FIG. 11—DIAGRAM OF DISTORTIONS OF BRIDGE DURING STEEL ERECTION

They promise to be a permanent contribution of great value to suspension bridge engineering. These tests have been described somewhat fully in a paper read by Clement E. Chase before the Franklin Institute (*Journal* of the Institute, October, 1925).

To verify a vital element of the tower design, hence of the stability of the bridge, tests were undertaken to show whether the web plates are in danger of buckling or crinkling in their free width between edging angles. The design had been made according to an established rule which limits the width of a web plate in compression to 30 times the plate thickness, but the experimental basis for this rule was considered inadequate to justify its use in a structure of such extreme proportions as these towers without further verification. Fourteen web plates bordered by flange angles, 35 in. wide over angles (or 26 in. wide between inner rivets) and 10 ft. long were tested in endwise compression, the web plates varying from $\frac{3}{8}$ in. to $1\frac{1}{2}$ in. in thickness. They failed at loads of 43,000 to 46,000 lb. per square inch (one failed at 40,500), the effect of web thickness being somewhat obscured by the different physical properties of the steel in the thick and thin plates. The tests indicated that the rule is conservative and the towers amply safe.

The cable wire splice, consisting of a right-and-left-thread sleeve, ends of wires being mitered at 45 deg., was tested in a large number of specimens. Advance tests showed a minimum of 95 per cent efficiency, the later tests (during actual cable spinning) 97 to 98 per cent efficiency, in spite of the fact that the swaged threads reduced the wire section 18 per cent.

To determine whether the high strength of drawn wire is a surface effect (which might be destroyed by superficial rusting) or extends through the wire, tests were made on the whole wire and on wire ground down to successively smaller diameters. The tensile strength was practically unchanged throughout the diameter ranging from 220,500 to 236,000 lb. per sq.in.

To investigate the effect of lateral pressure (as in the cable saddles) on the tensile strength of the wire, a piece of wire was tested under lateral pressure of 4,300 lb. per lineal inch. It was only 1 or 2 per cent weaker in ultimate strength than a wire tested without lateral pressure.

Wires tested in tension while bent around an 18-in. sheave (simulating the strand shoe) broke in the straight portion and showed a strength identical with that of wire tested straight, between grips.

With regard to the doubt as to whether cable assembled in strands would develop nearly the full efficiency of the wire (George S. Morison 35 years ago found only 80 per cent strand efficiency), strands of 37, 80 and 306 wires were tested, showing 96, 95 and 94 per cent efficiency respectively. In one specimen of the second set all wires were spliced, in the other none, yet both gave exactly the same strength. The 6 per cent reduction shown by the 306-wire strand is believed to be greater than occurs in the cable, as the strand laid up for test (around strand shoes) could not be laid up with as uniform tension as was obtained in building the bridge.

To determine the flexibility of a section of cable and therefore permit estimating secondary stresses, a length of cable 9.4 in. in diameter tested as a beam proved to be almost as stiff as a solid beam under quite small loads, but under moderately larger loads was 15 to 45 times as flexible. An analysis made from the results

permitted an estimate to be made of the secondary stresses in the main cables of the bridge.

The friction of cable bands was tested on this 9.4-in. cable and later on a 30-in. cable. Friction tests of flat blocks of various degrees of roughness on pieces of wire had showed friction coefficients up to 25 per cent, but band-slipping tests on the two sizes of cable indicated a longitudinal resistance of about 60 per cent of the gripping force, presumably due to bulging. The bands were designed to utilize 15 per cent friction.

Since the suspender ropes pass around the cable bands, tests were made of such ropes bent around sheaves, no previous data on wire-rope-center cable tested in this way being available. Tests around a 32-in. sheave showed a loss of strength of 11 per cent as compared with rope in direct tension. Suspender rope was also tested for modulus of elasticity, which was found quite variable depending on the previous history of the rope. Cable was tested for degree of compaction and other minor tests were made, all of direct assistance in the design, but of less importance for record.

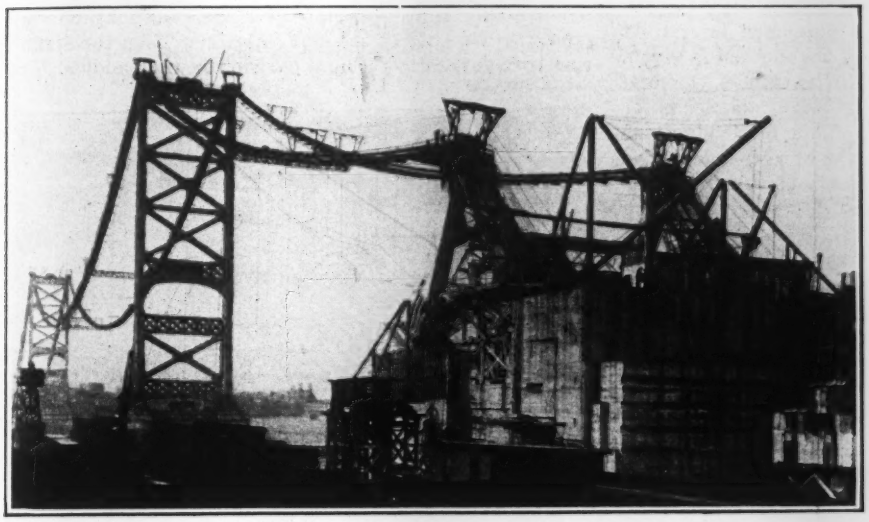


FIG. 12—CABLE-SPINNING UNDER WAY

A footbridge under each cable, carried on six 2¼-in. wire ropes, carries the guide frames, for an endless traveling rope over each cable position, by which four wires are laid at each trip from anchorage to anchorage.

Some Features of the Construction Work—Before setting the tower shoes on the completed granite top of the main piers, the pier tops were chipped level on the entire area to be covered by the 4-in. steel slab. This chipping was done by first cutting down a number of distributed small spots to the correct elevation, as determined by engineers' level, then cutting down channels to connect these spots and working them to the true level line, and finally connecting the areas between these lines. The finished surface is true to $\frac{1}{32}$ in.

Erection of the towers, carried out by the Bethlehem Steel Co., contractors for the fabrication and erection, went forward with little complication other than that introduced by the great weight of the sections and the necessity of entering the vertical splices between the four sections into which the post cross-section was divided for fabrication purposes. The lowest sections of the tower were erected by a floating derrick, but after the first panel of sway-bracing between the posts had been erected, vertical I-beams were attached to this bracing, to serve as a runway for a vertically traveling derrick platform capable of moving up with the advancing steelwork, and the derricks on this platform placed all the remainder of the tower steel.

Some difficulty was experienced in making the vertical splices in the base sections of a Camden tower post. Though the joints had been machined true and had been fitted together in the bridge-shop yard, it seemed that one of the erection pieces was slightly drawn out of shape in riveting the 2-in. base plate to it, and then could not be forced true by all the loading at hand. The base plate was finally cut loose, and the section could then be drawn readily into good contact and match.

Riveting the tower sections presented the problem of supplying hot rivets to the inside of the tower. This was handled most ingeniously by heating the rivets at the base of the tower and sending them up to the riveters by a pneumatic delivery tube.

In the trusses and other heavy members of the bridge the rivets are generally 1 in. in diameter, and many large grips occur, especially in the towers. All rivets are of soft steel, 52,000-60,000 lb. per sq.in. ultimate strength, even in the nickel-steel and silicon-steel members.

As erected, the tower was plumb. In the finished condition of the bridge, it was desired to have the posts bent back 5 in. from plumb position, under normal dead-load and abnormal temperature, to equalize stress conditions between the opposite extremes of loading. Thus in connection with the stretching of the cables from anchorage toward mid-span as their own weight and the weight of the suspended superstructure came upon them, meant a progressive movement of the tower top toward the river as the erection of the cables and suspended structure should proceed, and therefore required either that the saddles be slipped forward on the towers at some stage of the work, or that the towers be pulled back before cable spinning started. The latter course was adopted, and by means of special pull-back ropes fastened to tower tops and leading back to the anchorage the towers were pulled back 11 in. As each strand of cable was completed and was transferred from its temporary sling support over the tower-top saddle to its permanent place in the saddle, it was shifted riverward of its true position, thus raising the land-span curve higher than its final position, so as to take over part of the pull-back force on the tower and put the cable in the proper position for equalization of the subsequent stretch of the cable.

Spinning Cables—Spinning the cables was done by the method which has been long standard in suspension-bridge construction, in fact since John A. Roebling's early work, and was nearly identical with the procedure followed in the cable spinning of the Bear Mountain bridge. However, as done here it represents the highest point of a perfected art, and remarkable speed and efficiency of working were attained. A more detailed

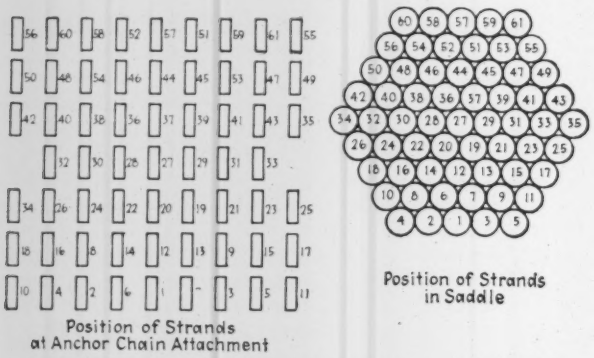


FIG. 13—ARRANGEMENT OF STRANDS IN CABLE

account of the procedure will be published later. At present only a sketchy indication of the method is given.

A temporary footbridge was built just under the final cable position, with two parallel 10-ft. platforms or walkways, one under each cable. This footbridge was carried by four sets of three lengths of suspender rope, two sets (or six 2¼-in. ropes) for each of the two walkways of the footbridge. This bridge was stayed by inverted catenaries or storm cables hitched to the tower bases. Above the footbridge two endless traveling ropes were arranged, one over each cable position. Each traveling rope extended from anchorage to anchorage, over supporting sheaves on the tower tops, and passed around horizontal sheaves at the anchorages. Two sheave carriages were fastened to each

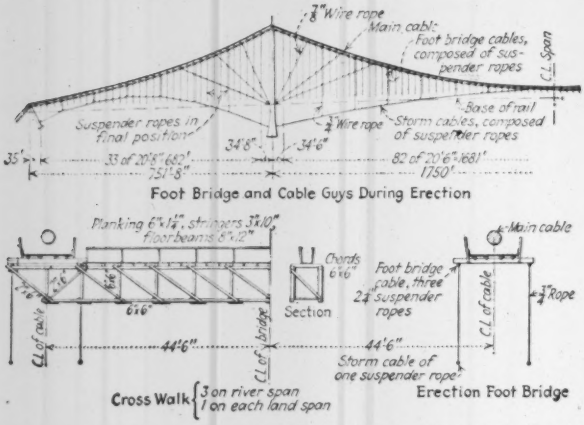


FIG. 14—DETAILS OF FOOTBRIDGES FROM WHICH CABLE SPINNING WAS DONE

traveling rope, and as this rope moved the carriages traveled across the river. A bight of cable wire from a large reel of wire was placed over the traveling sheave and was carried by it across the river, laying one dead and one live length of wire into a strand. Thus four strands, two in each cable, were in construction simultaneously. As soon as a bight of wire was across, and the bight was removed from its sheave and looped around the strand shoe at the far end, both wires were adjusted to the sag of the strand, the adjustment being first carried out from the initial strand shoe progressively along the length of the dead wire, and then backward across the river along the live wire. The wires when adjusted were clamped to the strand shoes, and the traveling sheave moved back over the river with another bight, taken however from a reel at the anchorage it was now leaving, in fact the reel whose wire it had carried on the previous trip in that direction. Thus each carriage was working on two strands.

Usually one one-way trip required about 8 min., so that 60 wires per hour could be laid under ideal conditions. The best day's work done was 578 wires, but generally it took four days for a set of four strands, or 1,224 wires.

When a strand was completed, it was seized every two feet with flat band clips of soft steel, devised by H. D. Robinson as an improvement on the wrapped wire seizings used in former cable works, and then was adjusted to correct sag as indicated by a previously strung guide wire of carefully adjusted length between anchorages. This adjustment of the strand was made by inserting shims in the strand shoe, as may be seen from the drawing of the shoe, Fig. 10. Then the strand was transferred to its final position in the saddles. The

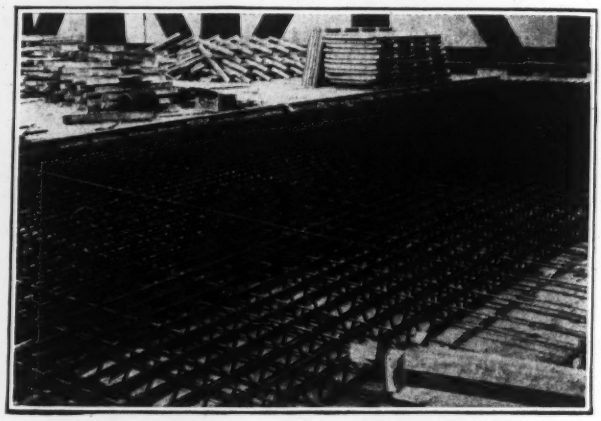


FIG. 15—FLOOR SLAB REINFORCEMENT
Trusses 4½ in. deep spaced 6 in., set transversely, and longitudinal temperature rods top and bottom.

relative position of the strand shoes and the corresponding strands in the hexagonal section of the cable in the saddles is indicated by a sketch.

After completion of the cable the assemblage of strands was compacted and formed to true circular section by a squeezer made of six 30-ton hydraulic presses seated radially on a ring and bearing on the cable through segmental shoes. Then the suspender bands were placed, the suspender lengths were carefully computed from the known position of the cable and the modulus of elasticity of the suspender rope, the lengths of suspender rope were cut to the required dimensions and socketed and placed around the band, and the structure was ready for the erection of the suspended steel work.

Cable construction covered the period from May to December, 1924, except for the compacting. The 37,332 wires of both cables were laid up in 24 weeks. The work was done by the Keystone State Construction Co., using wire manufactured by the American Cable Co. at the plant of the Page Steel & Wire Co. at Monessen, Pa.

Stiffening Truss Erection—This work, done by the American Bridge Co., involved a number of consecutive erection stages, to avoid heavy partial loading. Work was begun by 106-ft. booms rigged to the towers, which placed the posts, chords, floorbeams and stringers of three or four panels, on which traveling derricks could be erected.

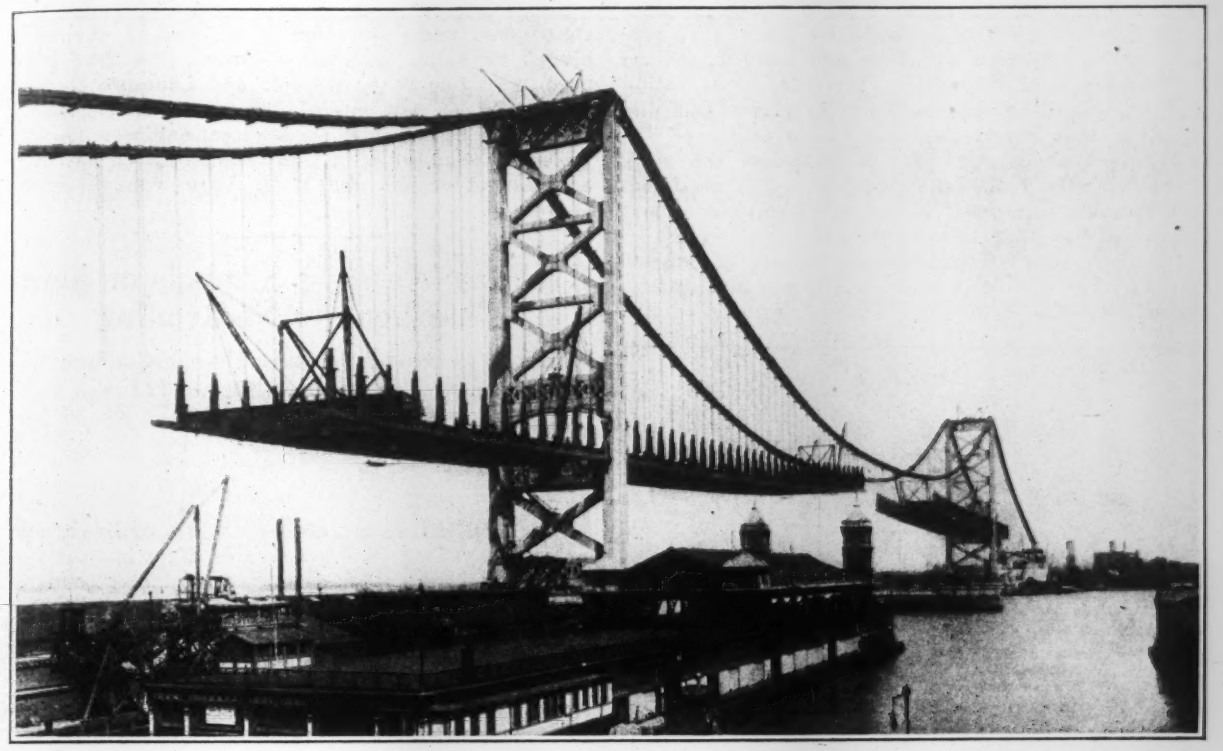


FIG. 16—FIRST OPERATION IN ERECTING THE STIFFENING TRUSSES
An abnormal distortion of shape occurs temporarily during the steel erection, due to the unbalance of loading. The construction procedure was so controlled as to minimize this distortion.

After this preliminary, in the first stage a traveler moved out from each tower toward midspan and another toward the anchorage, and placed the least weight of material that would carry the travelers; it erected the posts (hanging them to the suspenders), the bottom chord, the floorbeams and enough stringers to carry the travelers, except that near midspan the diagonals and top chord also were put in place. The largest distortions occurred in this stage, as it was necessary to erect 7,000 lb. of material per lineal foot of bridge, while the cables and accessories weighed only two-thirds as much. In the second stage the travelers returned, setting the truss diagonals. In the third, moving outward again they erected the top chord, while in the fourth pass they placed the remaining floor material, the sidewalks and the outer track.

Throughout these moves the structure was constantly changing shape (see diagram, Fig. 11), and it was a matter of most careful forethought to arrange conditions so that splices could be made. The diagonals were mainly connected during the fourth pass, but the chord splices were pinned and riveted while the floor-slab concrete was being poured, in order to utilize the arbitrary load distribution that could thus be obtained. The bottom chord of the main span and the top chord of the side span were connected first, while pouring part of the side-span slab (which raised up the main span). The other chords were riveted progressively during the concreting of the main-span slab, which proceeded outward from the west tower across the span, but to connect the splices near the center an extra loading of 300 tons had to be placed at midspan to weigh down the span curve. Also, the web of one splice was so refractory that recourse was had to lengthening the chord members by heating with oil torches to bring the splice faces to bearing.

A feature of the erection was the necessity of disconnecting and reconnecting half the suspenders in setting the top chord in place. The suspenders engage the posts, and pass through holes in the top chord. As the top chord was built in two-panel lengths the intermediate suspender had to be taken off the post and passed through the holes in the chord before it was finally in place. To do this a special pulling rig was built, by which the suspender was pulled down, away from its bracket seat on the post, and released by taking out the adjustment shims provided under the bracket; later it was reconnected by a similar procedure.

Altogether 18,500 tons of steel were erected in the trusses and floor, which was done in less than 9 months. As noted, steel erection and floor concreting overlapped, and both operations were comprised between March 3, 1925, when the first steel was erected, and Dec. 8, 1925, when the last section of slab was poured.

Construction of the floor slab was carried out by F. J. Boas. Wooden forms designed for repeated re-use were provided. They were handled from a scaffold one panel long, the full width of the bridge, supported by beams passed through manholes in the floorbeam webs. The forms could be stripped and moved ahead very rapidly. Concrete was hauled out on the bridge from a central mixing plant at the west tower by means of one-yard dump-body motor trucks running on plank roadways laid over the stringers. A somewhat wetter concrete than desired for maximum strength was used, to give smooth soffits, with excellent results in this respect. The forms were vibrated by pneumatic rub-

ber-shod hammers. The mean strength of test cylinders at 28 days was 2,700 lb. per sq.in. for the 1:1½:3 concrete of the suspended structure, and 2,200 lb. for the 1:2:4 concrete of approaches. The order of concreting was determined by the engineers, to give a load distribution that would facilitate the riveting of the stiffening-truss connections. Nevertheless the work proceeded with remarkable rapidity. The maximum rate of concreting was five expansion sections (about 200 ft.) of slab 57 ft. wide in one day.

Lighting and Traffic Provisions—Unusually complete and effective provision was made for traffic safety, traffic control and lighting. These features of the

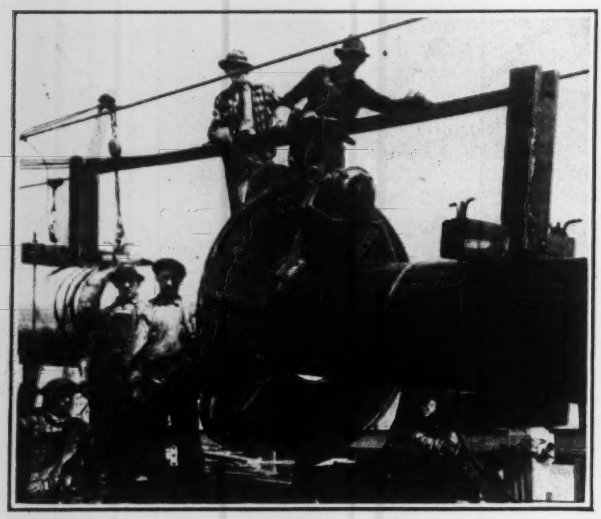


FIG. 17—WRAPPING THE CABLE BY POWER
One of the most important finishing operations. A soft steel galvanized wire is wrapped in a close layer around the 30-in. cylinder of cable wire.

bridge will be dealt with later, in view of the exceptional character of the bridge due to its size and its toll operation. Briefly, a very heavy two-level steel curb is provided at the edge of the roadway, and outside and above this is a heavy pipe railing. The track spaces are not in use or fitted for service at present, as no arrangements have been made for street-car operation. Therefore the inner track space is floored with galvanized grating and curbed with steel-mesh fencing, as a further guard against vehicle accidents. Lighting is provided by a lamp standard (or bracket from the trusses) every 120 ft. on either curb line, with 1,000 cp. per lamp.

To systematize traffic, white-paint lane borders have been painted on the roadway, and the middle line is protected by cast-steel buttons about every 100 ft. Toll collection is done wholly at the Camden end, where a roadway widening between the end of the approach incline and the terminal plaza gave room for installing seven tollhouses commanding five two-lane passages, two being fitted with scales for check weighing of trucks.

Traffic—Vehicle traffic turned to the bridge in unexpected volume as soon as it was opened. During the first two months about 1,500,000 private passenger cars crossed, and in addition there was a bus traffic reaching 1,700 per day and a truck traffic of nearly 1,000. This exceeds the most liberal estimates made in advance of opening, and makes certain the business success of the undertaking.

Engineers—As already mentioned, the bridge was constructed under direction of a board of engineers, headed by Ralph Modjeski, chairman and chief engineer, with George S. Webster and Laurence A. Ball as associates. The engineering staff was headed by Clement E. Chase, principal assistant engineer, Leon S. Moisseiff, engineer of design, Allston Dana, assistant engineer of design, and M. B. Case, senior resident engineer.

Highway Warning Symbols or Signs That Require No Reading

Outlines Designed for Quick Recognition and No Lettering to Become Illegible Through Disfigurement or Glare

BY E. T. SCOTT
Los Angeles, California

AUTOMOBILE drivers observe that the outline of road signs and of various forms of advertising can be made out clearly at much greater distances than the words or symbols painted thereon can be read. This suggested to the writer that outline symbols would be a more effective warning to the motorist than the printed sign, because the former would convey meaning more quickly and thus would give the driver more time to prepare for what lay ahead. Eight outline symbols were accordingly made in the shapes shown in the accompanying drawing, Fig. 1. These were set up along the roadway and photographed under day and night

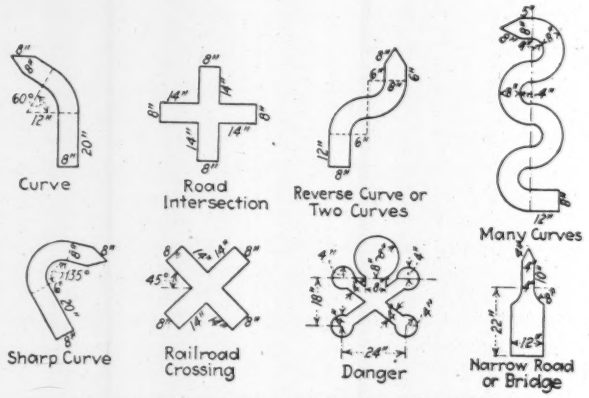


FIG. 1—DIMENSIONS OF HIGHWAY OUTLINE WARNING SYMBOLS

conditions, with the results shown in the accompanying pictures.

The symbols were cut out of sheet metal and to the metallic outlines three coats of ordinary white paint were applied. They were mounted on posts painted black in order that the outline would be kept distinct and were set up along the highway where they could be compared with the usual warning signs. The night pictures were made using only the illumination afforded by the headlights of an automobile stopped on the highway 75 to 200 ft. from the outline symbols.

While the pictures largely speak for themselves it may be noted that in Fig. 2 the symbol indicating a curve is instantly recognized although the curve on a standard type road sign alongside can hardly be made out and the lettering is altogether illegible.

Fig. 3 shows the striking impression of the danger symbol coupled with the symbol indicating railroad crossing. Fig. 4 indicates the clear effectiveness of the outline symbol under either day or night light conditions.

Fig. 5 shows the relative advantage of an outline symbol and a standard sign under conditions of rather low visibility during the day.

warn the motorist of some approaching danger but also to warn him what to prepare for. An arrow unmistakably indicating the direction of a curve is more effective than a sign which reads "Slow, Curve" after which the driver must wait until the curve comes into view before he knows which way he must turn. In short, suitable outline symbols increase the safe speed of both day and night driving.

Fig. 2—Moderate curve signs—Ontline type on left.

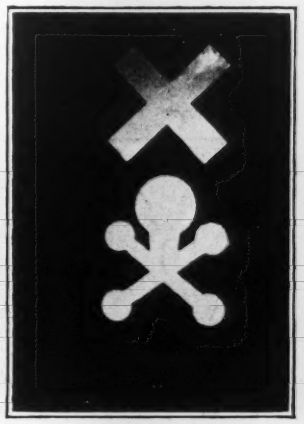


Fig. 3—Night view of "dangerous crossing" sign.

Fig. 4—Symbol indicating narrow way ahead by day and by night.

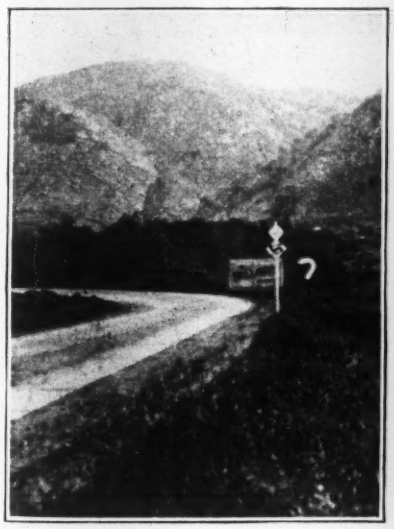


Fig. 5—Outline warning compared with usual sign, by day and night.

Fig. 6—Reflected rays obscure text on sign.

FIGS. 2-6—HIGHWAY WARNING SIGNS THAT REQUIRE NO READING

Fig. 6 illustrates the manner in which reflected rays of light can obscure lettering and symbols on the standard sign. The outline symbol in this view is subject to the same light conditions but its value as a warning is not affected by the reflected rays.

The motorist has but little time to decipher indistinct warnings or to read printed notices. The warning that a road sign is intended to convey should be apparent at a glance under all light conditions. Outline symbols have certain advantages over the ordinary signs in meeting these requirements; they are simple to construct, no sign painter is needed to letter them and a few holes shot through them by vandal hunters do not destroy their usefulness as in the case of ordinary signs, for the outline remains. They can be made not only to

These symbols are not patented and the author's hope in writing this description is that it may be of value in securing better posted highways.

Society Membership Incorrectly Stated

In an article entitled "Concrete Bridge Designed for Elastic Movement," in our issue of June 24, 1926, p. 1022, the author's title was given as "Member, Institution of Civil Engineers, London." This statement was in error. It came about through the author abbreviating his title after attempting to translate it into an English equivalent for the French society. The author is not a member of the Institution of Civil Engineers, but is a member of the Société des Ingenieurs Civils, France.

The Florida Hurricane and Some of Its Effects

—Report on a Brief Engineering Reconnaissance

A New Storm Datum—Lake Okeechobee Blown Over Levee and Town Destroyed—First Failure Test of Tall Building Construction—Resistance of Houses, Towers and Other Structures

By F. E. Schmitt
Associate Editor, *Engineering News-Record*, New York

FIRST REPORTS from the southern Florida region which was swept by a Caribbean hurricane on Sept. 18 told of unprecedented effects, including the wrecking of the 17-story Meyer-Kiser Building in Miami, and suggested that this hurricane would make important additions to storm experience and protection. A brief reconnaissance of the storm area fully confirms this, and shows that the storm will prove to be of far-reaching importance in its bearing on engineering design. Definite knowledge will have to await full local and official study of the facts, but for earlier information the following report sets forth some of the salient engineering facts as seen in this reconnaissance. It is an amplification of a telegraphic summary Sept. 30, p. 554.

Features of the Storm—Dependable records of wind velocity and rainfall are lacking, but general opinion along the lower East Coast, including that of the weather officials, agrees in ranking the hurricane as

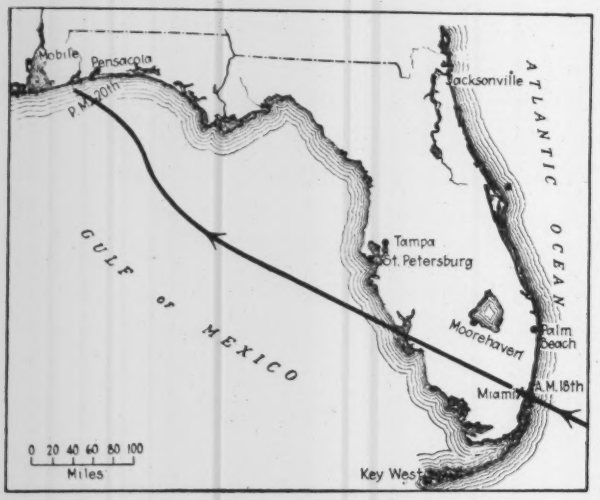


FIG. 1—APPROXIMATE TRACK OF HURRICANE CENTER

the most violent in memory and in some 50 years of record. Conditions farther west confirm this, according to F. C. Elliot, chief drainage engineer of the Everglades Drainage District, who is perhaps better acquainted with the Everglades country than any other man; great cypress trees were broken off by this storm, and since nowhere in the interior regions have evidences of any similar effects of earlier storms been encountered, he concludes that probably in a century or more there has not been as violent a storm in southern Florida. The Miami weather observer, R. W. Gray, reports that the barometer went lower (minimum 27.62 in.) than any record in the United States (minimum 28.11 in., at New Orleans).

The Miami weather instruments are located on the roof of the three-story Post Office building, which during the past two years has become surrounded by high office buildings. The anemometer record shows the greatest 5-min. wind movement as 80 m.p.h., with 1-mile maximum of about 85 m.p.h. But Mr. Gray says that wind records during the last year have averaged lower

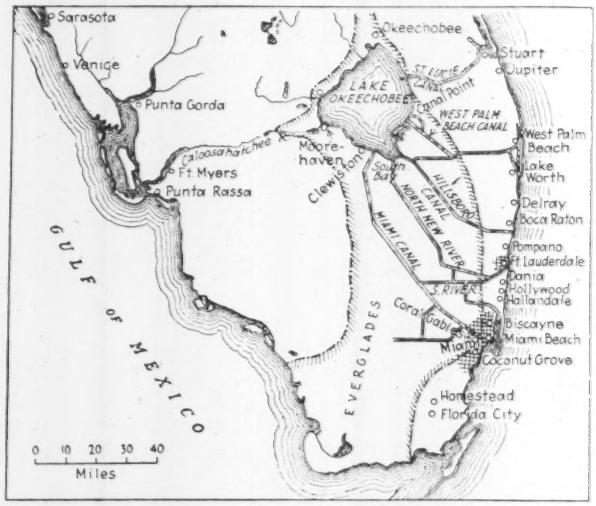


FIG. 2—SECTION OF FLORIDA SWEPT BY STORM

than before the high buildings were erected in the ratio of about 1 to 1½, and he takes 1.4 as the factor for estimating actual wind velocities in the storm. This makes the maximum wind velocity 110 to 120 m.p.h. Other estimates range from 130 m.p.h. upward.

Torrential rain fell, though the records are not complete. The Miami rain gage was carried away by the storm. The rain "fell" horizontally. Observer Gray believes the total fall on Sept. 18 to have been very great, as water conditions in the western part of the city were worse than after a fall of 15 in. in 24 hr. last November. He gives 8 in. of rain as an "extremely conservative" figure. The rainfall was most intense during the most violent period of the wind. However, in addition to the rain, the wind also carried much spray, and near the shores of the ocean and Biscayne Bay this must have formed a large part of the water in the air, which had a strong salty taste especially during the second half of the storm. That the wind drove the sea water powerfully is indicated by the 7-ft. rise of the ocean at Miami Beach and the greater rise (10 to 12 ft.) along the west shore of the bay, which carried large boats up on the land and swept over the causeways crossing the bay.

Lake Okeechobee rain gages averaged 12.2 in. At West Palm Beach the fall was only 2 in., but 30 miles northward at Lock 2 of the St. Lucie canal it reached 14.27 in. Lake Okeechobee itself showed a rise of about 1 ft. after calming, which closely represents depth of rainfall before water came in from the drainage area.

Coming of Storm—That a storm was coming from the West Indies was known Sept. 14 but there was no definite

FIG. 3—TYPICAL EFFECTS OF FLORIDA HURRICANE
Top picture, county causeway, with street railway tracks washed out of their roadbed (at center)
Middle views, Roosevelt Hotel, Miami, with tile wall panels blown in, and a concrete-block wall panel pushed partly out (westward)
Below, 200-ft. radio tower at Hialeah, looking north, tower down to north, and a shovel removing sand from Miami Beach drive.

knowledge where it would strike until Friday evening, Sept. 17. Hurricane warnings were ordered up by the Washington office of the Weather Bureau at midnight, but hours before this many persons had decided to take all possible storm precautions; the Florida Power & Light Co. lowered its gasholder bells and building man-

agers looked after their windows with special care. The wind blew a gale before midnight. At 12:30 the anemometer showed 36 m.p.h., but at the bay shore the wind was nearer 50 m.p.h. Shortly afterwards the hurricane was on.

From 1 or 2 to about 6 in the morning the wind blew with hurricane intensity from the northeast, and brought with it a torrential rainfall. This was the first half of the storm. At 6:10 the wind quieted and the rain stopped. The eye of the storm was passing Miami. The wind again rose for a short time, then came another lull, and at 7:15 the second half of the storm set in, with southeast hurricane winds and with a renewed deluge of rain. Between 9 and 10 the wind shifted to southwest, but continued at hurricane intensity, falling to a 40 to 50-mile gale by noon and coming to an end with the rain by the middle of the afternoon.

By the official anemometer the greatest wind velocity, 80 m.p.h., was reached about 5 a.m., whereas the second half of the storm had a maximum of only 60 m.p.h. But Mr. Gray believes that the present station error is much greater for southwest than for northeast wind, and all outside statements ascribe much the greater

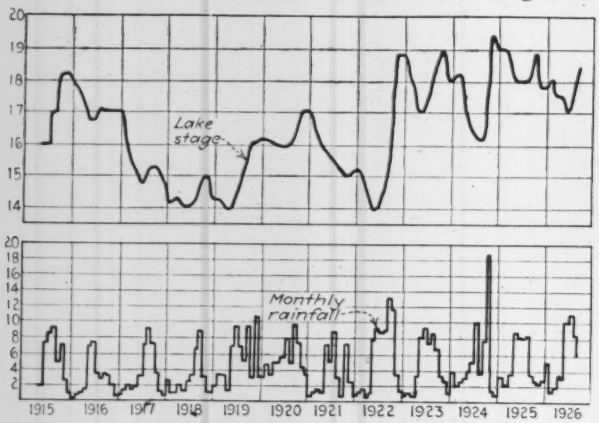


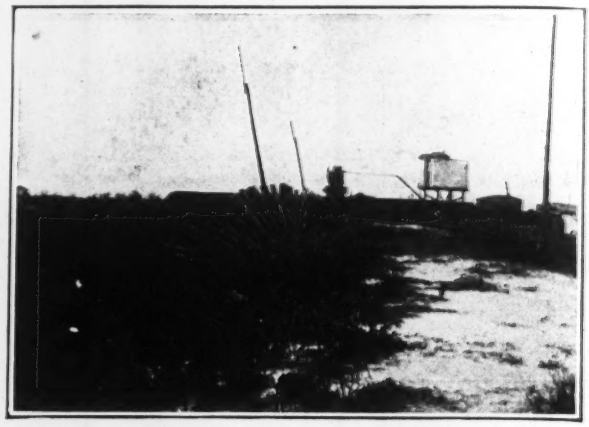
FIG. 4—TWO YEARS' RECORD OF LAKE OKEECHOBEE WATER STAGES AND RAINFALL
High stages for past four years due to wet cycle.

violence to the second blow. The Realty Board and Meyer-Kiser buildings show most marked damage from the south, and many other structures, trees, etc., are down to north-northwest.

Away from the center of Miami the storm was of the same character and violence, but north and northwest of the city its directions are given as north in the first half and south in the second. Radio towers at Hialeah, 8 miles northwest, were blown over to the north. At Coconut Grove, to the south, the wind is said to have been northeast and southwest. At Moorehaven it was east and southeast to south.

While each half of the storm is described as in the main a steady blow, without let-up, there were superimposed gusts that must have played a large part in doing structural damage. This is evidenced not only by the description of eye-witnesses but also by the effects of the storm. The anemometer records of course do not reveal gustiness.

Fig. 1 sketches the approximate track of the storm center, the barometric low, after a Weather Bureau chart. The path of maximum destruction at the east coast was 60 to 70 miles wide, with its northern limit at Pompano and its southern limit near Homestead and



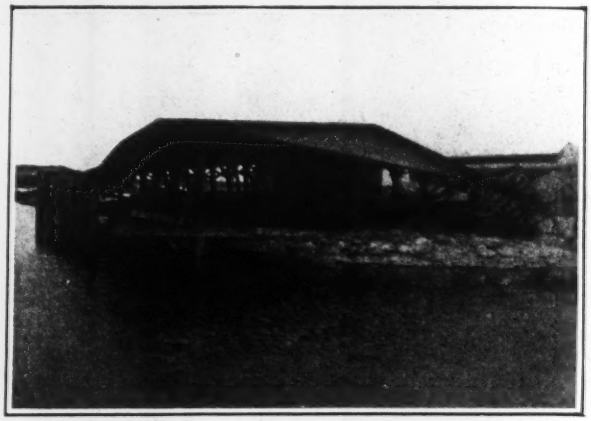
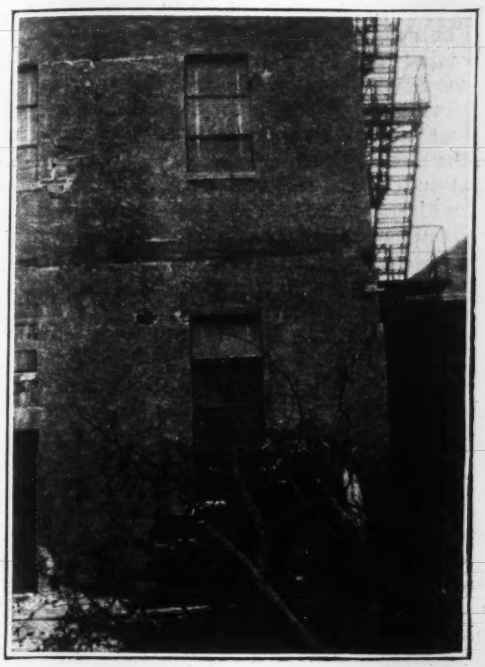


FIG. 5—FORCE OF THE STORM AT MOOREHAVEN
Above, railway track thrown from embankment 10 ft. above lake water level and 4 ft. above highest flood, and turned bottom up. Below, wrecked railway dock and warehouse on waterfront.

Florida City. As the uninhabited Everglades marsh begins 8 or 10 miles west of the shore, there is no indication of the storm's path until the west coast is reached. Moorehaven, 95 miles northwest of Miami, lies well off the track sketched in Fig. 1, yet it experienced hurricane violence fully equal to that at the East Coast; but reports from nearby places indicate a narrow path (15 to 20 miles wide). Mr. Elliot, whose assistant engineer, Fred Flanders, went through the entire Moorehaven storm and observed it closely, therefore suggests that the main storm divided over the Everglades, a small disturbance going northwesterly over Moorehaven and the main storm continuing nearly west. Along the Lake Okeechobee shore storm damage to houses and trees is apparent from Canal Point south and southwest, but is much more violent toward the west, beginning beyond Clewiston and ending 8 or 10 miles west of Moorehaven.

The Moorehaven Disaster—Moorehaven, a small farming community on low, partly reclaimed Everglades ground at the south corner of the lake, was both wrecked by the wind and submerged by a 7-ft. storm rise of the lake, which went over the levees and breached them. The flood caught many persons on the roads where they were trying to reach town for safety. The result was a far greater toll of life here than on the East Coast; at least 100 and possibly more than 150 out of a population of 2,000 were lost, though it is said only two or three deaths occurred in Moorehaven itself.

The pertinent lake conditions are briefly as follows: Lake Okeechobee is a shallow basin of 730 sq.mi., up to 25 ft. deep, bordered by fairly high ground in its north-west quarter, but along east and south by a low rim, 21 to 22 ft. above sea level. Mainly through the Kissimmee River it drains a 4,600-sq.mi. area of high annual rainfall (55 in.). Lacking a natural outlet, the lake until recently discharged its surplus waters by overflowing over the low rim into the wide-spreading Everglades marsh. But for some years past the southern lake margin has been leveed 22 to 25 ft. Several feet of shrinkage of the ground as it has dried out by drainage to the lower-lying Calyosahatchie and the Everglades canals increase the importance of this protection. The level of the lake originally varied from as low as 12 ft. to overflow. To regulate it in connection with drainage-reclamation of the Everglades, the St. Lucie Canal has been dug from its northwest corner to the sea, with two locks for controlling both lake outflow and land drainage. From the southern and eastern banks, five other canals extend to the sea, but these serve mainly land drainage and do not aid in lake drainage during the high water period. At present the St. Lucie canal is not yet at full width through a rock section near the upper end, and has only about 3,000 sec.-ft. discharge capacity, about half the ultimate. The inflow



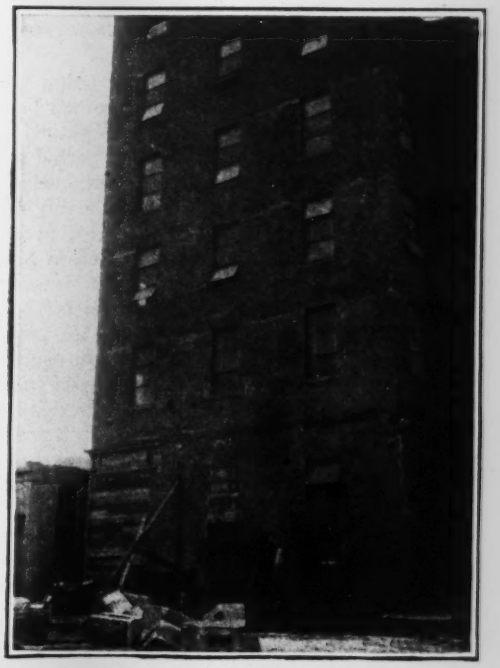
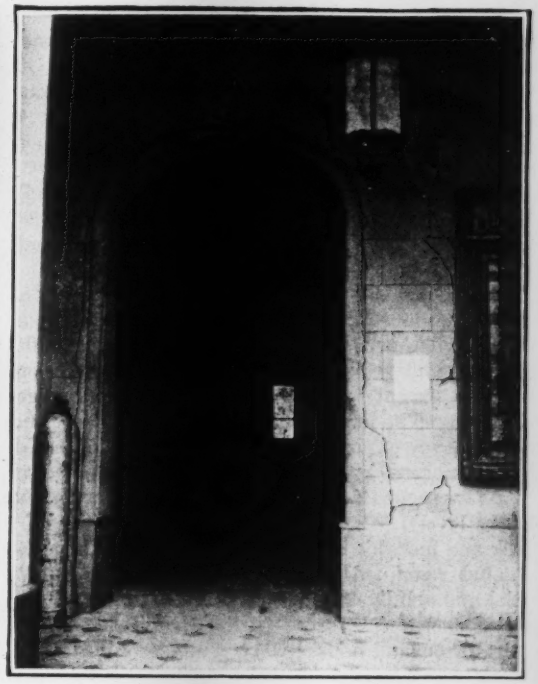


FIG. 6—REALTY BOARD BUILDING, MIAMI, DAMAGED BY STORM

Above, rear wall much cracked and lines of floor girders revealed by plaster spalling.

Below, arcaded front (west) wall, showing cracked lobby wall.



rate to Lake Okeechobee during flood time is 24,000 to 26,000 sec.-ft., and the total inflow during the rainy season represents nearly 6 ft. of lake rise. About 14 ft. is the lowest desirable lake stage at the end of the dry season, and 17 to 18 is the allowable maximum permissible in the rainy season.

Present discharge conditions not being adequate for flood runoff in wet periods, the lake has been high for several years. Fig. 4, a plot of lake stages and rainfall since 1915, indicates how a long dry period was followed in 1922 by the beginning of a wet cycle which still continues and has kept the lake at a high level. The present year already has had 58 in. of precipitation in nine months, against an average of 55 in 12 months.

Under these conditions, the lake stood at El. 18.5 just before the Sept. 18 storm. This is about the level of the cultivated ground back of the Moorehaven levees. The storm, beginning Friday night and increasing toward morning, carried rain and lake spray into the town in such volume that solid sheets of water seemed to be driving in, and (as in Miami) the water in the air made it impossible to see across the street.

During the first half of the storm the lake did not go above 22, well below the levees, yet the ground gradually became covered with water. By 8 to 10 Saturday morning the lake level rose to the danger line. As the wind drove the waters from the east shore to the west, they pocketed in the bay on which Moorehaven lies, and Observation Shoal, which spreads out before the town, probably piled up the water still more. At Canal Point, on the east bank, the lake dropped 4 ft.; at Clewiston it rose only a foot or two (to 22), and not much damage was done there; at Moorehaven it rose a total of nearly 7 ft. (to 25-26) and washed over the levees. The levees were topped and breached about the middle of the morning, the breaching occurring probably first by wash and then by cutting. Mr. Flanders says that at the worst of the storm it was hard to tell where water ended and spray began, and there was overflow and cutting before the lake level had reached the crest.

These levees, now five years old, were 130 to 140 ft. wide at ground level, with water side flattened to a sand and pebble beach of 1:5 slope. They were built of earth, shell and rock dredged from a borrow pit on the water side, except for a 2-mile length of muck levee near Clewiston. The latter, not yet built to full section, had its top blown off by the wind; in the other levee there are numerous breaks 50 to 150 ft. wide, some cut only a few inches deep, others 6 to 8 ft. (or below present lake level).

The lock and movable dam at the head of the Caloosahatchie canal remained undamaged, as did also a few substantial and solidly founded buildings.

General Structural Effects—In the East Coast storm area several thousand houses were completely destroyed and a very much larger number damaged—some by having the roofing partly stripped or a porch blown off, some by being unroofed or having a whole story torn away. Almost every type of construction and every material are represented in both the wrecked and the surviving houses, except that stone and brick were practically absent, their place being taken by hollow clay tile, hollow concrete blocks, and mass concrete made with the porous lime rock of the region (ojus rock or "coral rock").

Almost every conceivable form of wind damage is to be seen. It is easier to single out and describe individual, curious or abnormal instances of damage than typical or normal ones. In most cases, alongside a damaged house may be seen one which contradicts what might be deduced from the first one. It should be borne in mind that everywhere in the region there was very much flying debris in the air and that probably this was an important factor in the structural damage. However, some tentative generalizations may serve to summarize the storm effects.

The best-built structures resisted the storm either wholly or with minor loss. This applies to individual houses as well as to entire sections of fairly uniform character, such as Coral Gables. Light and flimsy construction correspondingly suffered, though with many surprising exceptions.

Good construction was not dependent on specific materials. Frame house construction being most largely represented, the most impressive fact is that good carpentry made an excellent showing.

Very many houses show the action of outward force or bursting, presumably by wind pressure acting through windward openings (generally broken windows) and lacking leeward vent. The most widespread effect of this was the lifting of roofs. Some one-car garages lifted off without even scratching the car within. Cement roof tile 2x4 ft. on two buildings of the city's water filtration plant at Hialeah were blown off by the pressure of wind entering south windows.

Anchorage failed very commonly, both in the lifting of roofs and in the lifting, rolling over or bodily shoving of houses and garages.

Parapet walls were blown over or torn off in great numbers. Hollow block construction was usually involved.

Hollow tile and concrete block walls other than parapets failed extensively. Most of the tile panels in the east face of the uncompleted Roosevelt Hotel were crushed in, and similar failure, either flexural or shearing (by deficient bond to the steel or concrete frame) occurred very widely all over the storm area. Concrete block walls proved just about as deficient. An instance was the blowing out of an end wall of an auditorium over a row of stores, where the wall rested on a reinforced-concrete girder and was held at the top by 10-in. channel purlins. Another instance is shown by Fig. 6, a sliding-out failure.

Roofing materials made an unsatisfactory showing. Roofs ripped away almost everywhere in whole or part. Sheet roofing cemented down is reported to have resisted much better than that merely nailed. Flying débris may have played a part in starting the destruction of roofing. Spanish and mission tile roofs, almost the characteristic architectural feature of the region, also were nearly everywhere damaged, even when fairly well cemented. In some mission tile roofs the convex tiles were blown off while the concave tiles remained. Wood-shingle roofs, although fewer in number, suffered relatively little and made the best group showing among roofing materials.

Windows were blown in everywhere, and window destruction was reported to have been the first happening in the wrecking of many houses. Instances of badly bent steel sash occur in business buildings. To what extent flying débris or water impact con-

tributed to window failure could not be judged, but the resistance of windows, sash and frames was very much below the general building resistance—a matter of importance in view of the blowing out effect of the wind.

An excellent summary of structural findings prepared by R. D. Spellman, structural engineer in the Miami

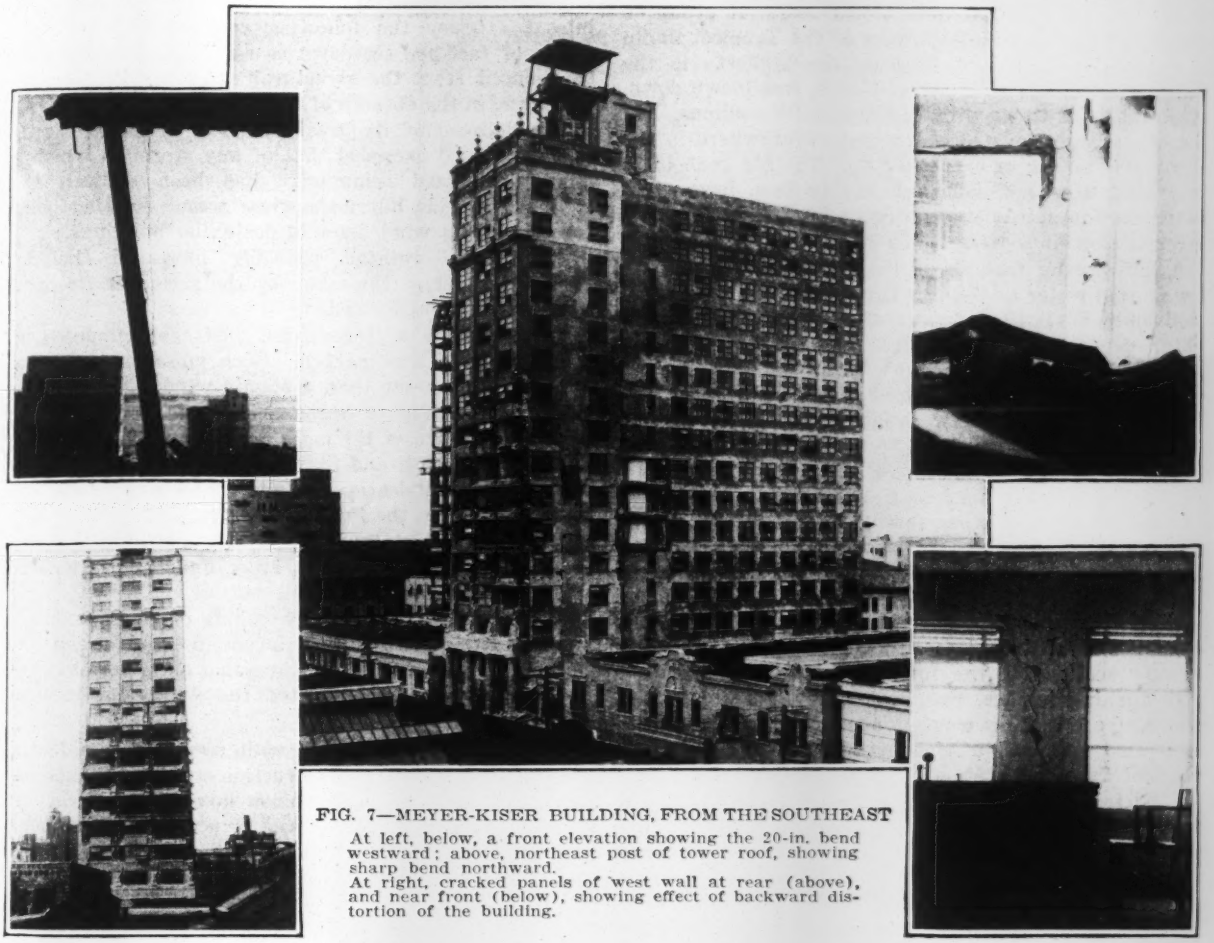


FIG. 7—MEYER-KISER BUILDING, FROM THE SOUTHEAST

At left, below, a front elevation showing the 20-in. bend westward; above, northeast post of tower roof, showing sharp bend northward.
At right, cracked panels of west wall at rear (above), and near front (below), showing effect of backward distortion of the building.

department of building inspection, expresses conclusions reached to date by the officials and engineers of the department:

No one particular type of construction resisted the hurricane better than other types, and there is nothing to show that some types are so weak as to be out of place in districts subject to hurricanes. From a broad study of the effects of the Sept. 18 hurricane it must be concluded that every type of construction, where intelligently designed and properly built, proved itself capable of resisting.

Windows are the weakest point in buildings of all classes. Failure and leakage of the windows caused most of the damage to the large downtown buildings, and was the beginning of destruction in the case of small residential buildings. Wind entering the larger buildings through broken windows in many cases wrecked inside partitions, while in smaller buildings it often blew out the far wall or lifted the roof.

Roofing of all classes seemed unable to withstand the storm, although there are excellent individual examples of roofs of almost every type that came through practically unscathed—whether because of especially good workmanship or chance protection cannot now be said. Wood shingle roofs, however, came through exceedingly well as a class.

In residential and ordinary building construction, the following points are worth attention: Wooden shutters would prove to be a wonderful safeguard to residences. In wood-frame buildings it is important to take particular care that the rafters are spiked securely to the sidewalls and the ends of all partitions are well spiked to the walls. Such buildings should also be anchored to their foundations, and should not have to depend on weight alone to resist being turned over or shoved off their base. Tile and cement block construction for residences, small stores and apartment buildings should be laid up in cement mortar. A continuous reinforced-concrete beam around the building and above the windows, forming the lintels and bearing on the masonry wall, demonstrated its effectiveness. Poorly built parapet walls, on the other hand, ruined many a building; in many cases the parapets broke off at the roof joists, leaving a broken roof surface for the storm to enter, while in other cases where the joists were not properly anchored the entire wall went out with the parapet.

Only two out of 25 or 30 large buildings in downtown Miami were seriously damaged by wind pressure. This would seem to indicate that if properly designed and built the pressure of 20 lb. per square foot specified by the present Miami building code is sufficient for buildings up to 20 stories high. The new code, however, will call for an increase in wind pressure depending on the height of the building.

No large concrete building in Miami was damaged structurally. Reinforced-concrete construction has the advantage of being much stiffer than structural steel. There is pronounced movement in steel-frame buildings long before the steel is overstressed. The deflection in long columns and beams, especially first-story columns, plays a part. The calculated deflection in the first story columns of the Realty Board Building checked surprisingly well with actual movement as disclosed by cracks in the walls.

Ordinary types of scaffolding and hoisting frames will not stand a violent hurricane. This was demonstrated in almost every instance in Miami.

Other Structures—Engineering structures other than tall buildings showed marked differences of behavior. A brick chimney and a steel stack, 150 ft. or more in height, at the main power house of the Florida Power & Light Co. in Miami, were blown over. A group of five triangular-base radio towers of the Tropical Radio Telegraph Co. north of Hialeah, the highest (in the middle) being 435 ft. above pedestals, was blown down, apparently due to buckling of the leeward columns. On the other hand elevated water tanks everywhere in the storm area so far as seen stood up. The big gasholders in Miami were not damaged, having been lowered in anticipitation of the storm. Some 70 miles of electric transmission lines were blown down.

A noteworthy fact about the elevated storage tank for filtered water of the city filtration plant at Hialeah is given by W. L. Black, assistant engineer of the Miami water department. This tank was reported to have swayed decidedly during the storm, and examination afterward showed that the rod diagonals between the four posts of the tower were loose. It was found that *the turnbuckles had unscrewed* two or three turns, the movement being plainly visible because the steelwork had been painted its final coat only a month before and the raw threads therefore showed unmistakably. From this account it must be assumed that the swaying of the structure set up combined jarring and straining of the rods and turnbuckles sufficiently to start the latter turning loose.

A fact related to this is that swinging steel-sash window sections in the Realty Board Building, fitted with turning latches, had been securely fastened the evening before the storm but all (or most) blew open. This also suggests a violent jarring or hammering effect of the wind gusts and building sway.

Steel truss roof structures in assembly halls, amusement buildings and the like were unharmed wherever seen.

City Buildings—Miami's youthful business district contained over 20 tall buildings of steel frame and reinforced-concrete frame—hotels and office buildings—from 12 to 20 stories high. As a whole they performed brilliantly. Though designed generally for 20 lb., and in a few cases 25 lb., wind pressure, all but two came through structurally undamaged. These two exceptions, however, suffered very serious injury.

The city building department states expressly that not one of the reinforced-concrete high buildings in the city shows a crack.

Apart from general resistance of the structures, however, it should be noted that projecting parts of parapets, ornaments and the like were torn off in a number of cases. Overhanging and roof signs were destroyed almost without exception, though required to be designed for the same pressures as buildings and subject to building-department approval of anchorage.

Five tall buildings under construction, all of them up to full height and mostly already inclosed, were not injured except for the blowing away of scaffolding, formwork, and loose objects. At the new Bank of Bay Biscayne building, five blocks from the waterfront on Flagler St., a double hoisting tower with two 6x6-ft. cages, framed of 2x6's with full diagonal bracing and tied in at each floor, was carried away for half its height, and 6-in. I-beam outriggers for scaffolding disappeared. At another, the hoist tower built in the elevator shaft and projecting above the roof had its tip torn off.

Conclusions—The two cases of seriously damaged office buildings require to be described more particularly. Several photographs are shown here, but before going into description the following conclusions and statements of fact are set down as representing what may be deduced from the structural events of the Florida hurricane in the absence of full detail of study.

(1) Because of its great violence, which so far as can be learned exceeded that of any storm to which a modern civilized community has been subject, the southern Florida hurricane gives a new starting point for estimating wind force in designing buildings.

(2) Intense rainfall probably increased the destructive effect of the wind, by the action of its mass when driven by the wind.

(3) Pulsation of force from gusts superimposed on the main wind was marked. Such pulsation may produce effects greater than a steady wind.

(4) Cumulative or resonance effects seem to have occurred in some of the more flexible structures (chimneys, towers, high and narrow buildings), probably by action of wind pulsations or gusts. In some cases they may have caused the failure of the structure.

(5) Lateral rigidity is a desirable feature of a structure, to prevent cumulative sway under pulsations of wind.

(6) The destruction and wrecking of houses exhibits the usual unaccountable variation in wind action and building resistance, but indicates that all materials when in good construction resisted the wind and in poor construction failed.

(7) Valuable conclusions with respect to residential and general building construction are to be expected from a study of the extensive house damage in the Miami territory. Some of the principal ones are summarized above in the memorandum of R. D. Spellman, and others may be expected as fuller study of the storm effects is made.

(8) Survival of nearly all engineering structures, ranging from high buildings to elevated water tanks, indicates that customary wind-pressure design is not far from adequate for even violent storms.

(9) Racking of two Miami office buildings under lateral pressure reveals the manner of action of tier buildings and will yield highly important new understanding of lateral resistance.

(10) The southerly part of the Meyer-Kiser building will permit making a close estimate of the actual storm pressure on the building, by computing the moments required to bend the columns. As the exposure of the building is fairly free both northeast and southeast, the result should represent a valuable basic figure for future structural design against severe storm winds.

In addition to the preceding, the Moorehaven tragedy directs special attention to the fact that storm action on shallow bodies of water may be of such severity as to warrant giving it special consideration in the planning of hydraulic works.

[*The second part of this report will follow in the Oct. 14 issue.—Editor.*]

News of the Week

CURRENT EVENTS IN THE CIVIL ENGINEERING AND CONTRACTING FIELDS

Civil Engineers' Board Meets in Philadelphia

Municipal Service Compensation to be Special Study—Medal and Prize Winners Are Announced

(Engineering News-Record Staff Report)

At a well-attended meeting of the Board of Direction of the American Society of Civil Engineers, held in Philadelphia, Oct. 1 and 2, just prior to the annual convention of the society, the board took cognizance of a serious condition alleged to prevail generally throughout the country with respect to the inadequate compensation of engineers in municipal service and of the unfavorable influence this condition may have upon the quality of municipal engineering service. Appointment of a special committee of the society was authorized to investigate and take appropriate action on the subject. It is expected that the early attention of the committee will be directed toward the present situation in New York City.

The board also approved a recommendation that the budget for 1927 provide allotments to the several local sections based upon each section's estimate of its needs as reviewed by the committee on local sections, rather than upon the flat rate per member to all sections as has been the practice hitherto.

New Committee Authorized

Final action was taken adopting a by-law creating the new standing committee on Technical Procedure, composed of representative of the Board of Direction, the Research Committee, committee on Publications and the several technical divisions, which is to co-ordinate all the technical activities of the society. The title and functions of the former committee on Technical Activities and Publications have been correspondingly changed and that committee will henceforward be known as the committee on Meetings and Publication. Another by-law was adopted reorganizing the Research Comr ittee to provide for greater continuity in its personnel and more effective supervission over the research work of the society.

The board voted to continue the financial support of the society for the observations now in progress on the Stevenson Creek test dam.

Three hundred and thirty-one applications for admission and transfer were considered and acted upon. It was announced that applications for this year have been more numerous than during any other year in the history of the society.

Notwithstanding a movement looking toward a revision of the present districts the board decided to make no changes for the year 1927.

The medals and prizes for papers submitted to the society were awarded as follows:

Norman Medal to Julian Hinds, of J. G. White Engineering Corp., Aguas Calientes, Mexico, for his paper on "Side-Channel Spillways: Hydraulic Theory, Economical Factors, and Experimental Determination of Losses."

J. James R. Croes Medal to C. S. Jarvis, of U. S. Bureau of Public Roads, Washington, D. C., for his paper on "Flood-Flow Characteristics."

Thomas Fitch Rowland Prize to Nicholas S. Hill, Jr., of New York City for his paper on "The Oradell Dam of the Hackensack Water Co."

James Laurie Prize to Lewis A. Perry of Longview, Wash., for his paper on "The Hexagonal Slab Design of Concrete Pavements."

Arthur M. Wellington Prize to Col. Charles W. Kutz, of Cincinnati, Ohio, for his paper on "Relation of the Ohio River and its Tributaries to Transportation in the United States."

The Collingwood Prize for Juniors to Cecil Vivian von Abo, of Johannesburg, South Africa, for his paper on "Secondary Stress in Bridges."

At the opening of its meeting the board adopted resolutions of regret over the deaths of Desmond FitzGerald, past-president and honorary member, and Alfred Craven, past vice-president.

During its session the members of the board were guests at several functions tendered by the Philadelphia Engineers Club, the Philadelphia Section, Am. Soc. C. E., the Associated Pennsylvania Constructors, the Philadelphia Building Chapter of the Associated General Contractors and by Robert W. Lesley of Haverford, Pa.

Engineering Fifty Years Ago

From *Engineering News*, October, 1876

THE highest trestle bridge on the Pacific Coast is the one in course of construction across Brown's Canyon, 2 miles northwest of Freestone, Sonora County, on the line of the Northern Pacific Coast R.R. It will be 135 ft. in height from the bed of the canyon and 600 ft. in length.

* * *

The railroad bridge across the Mississippi River at La Crosse, Wis., is chargeable with inducing more profanity among raft-riders than any other "snag" on the river.

Railway Track Subject at Chicago Session

Engineers Have Prominent Part in Roadmasters and Maintenance-of-Way Three-Day Session

Railway engineers had a prominent part in the proceedings of the Roadmasters and Maintenance-of-Way Association held at Chicago on Sept. 21-23. In addition to the subjects listed in *Engineering News-Record* of Sept. 16, p. 478, there was a paper by L. Adams, assistant to the president of the Union Pacific Ry., on the seasonal distribution of trackwork to promote more uniform employment throughout the entire year. In an address on "Placing the Track Department on a Business Basis," Charles A. Morse, chief engineer of the Chicago, Rock Island & Pacific Ry., condemned the uneconomic way which this department is administrated as a rule. For example, with the monthly allowance system of handling expenditures, from 10 to 25 per cent of the allowance is wasted, owing to continual disruption of forces and the frequent occurrence of a large allowance for extensive work when traffic is heavy and a light allowance when traffic is light. Another defect is the failure to plan definite programs for the routine maintenance work. As to the labor question, Mr. Morse considers the uniform wage system detrimental, and he would grade the forces as trackmen, helpers and laborers.

Terminal Layouts

In regard to the paper on turnouts in large terminal layouts, by H. J. Pfeifer, chief engineer of the Terminal Railway Association of St. Louis, the discussion approved his recommendations for eliminating the widening of gage and superelevation of rails on curves in such layouts. On the subject of rail joints, a committee report referred to the trouble from bolting joints so tightly that rails cannot slip in expansion movements. This condition has been accentuated by the use of heat-treated bolts which will not stretch when the nuts are screwed up too forcibly; it occurs also in spite of the use of spring nut-locks. In a vote as to the merits of four-bolt and six-bolt joints, the former (with 24-in. splice bars) was favored by a large majority, although the report rather favored a long six-bolt, three-tie joint. Officers were elected as follows: President, J. B. Kelly, general roadmaster, Soo Line Ry.; vice-presidents, J. P. Davis, engineer maintenance-of-way, Central Indiana R.R., and H. R. Clarke, general manager of permanent way, Chicago, Burlington & Quincy R.R.; secretary, T. F. Donahue, general supervisor of track, Baltimore & Ohio R.R., Pittsburgh, Pa.

Construction Council to Meet in Cleveland Nov. 8-10

The fifth annual convention of the American Construction Council will be held at the Hotel Cleveland, Cleveland, Ohio, Nov. 8-10.

Under the auspices of the Council at this time will be series of conferences dealing with the fundamental relations of the construction industry to the public on such subjects as the permanency of building construction in relation to hazards of life and investment; public and private plans for housing financing; methods of certifying building materials; good workmanship; and town and city planning and city building in relation to city growth, city values and community standards.

Other topics such as those having to do with practical methods of reducing construction peaks and depressions not only in relation to the construction industry but also to transportation and industry generally will receive attention.

The Council's officers are: president, Franklin D. Roosevelt; vice-presidents, Harry A. Wheeler, president Union Trust Co. of Chicago, George A. Harwood, vice-president, N. Y. Central R.R., and D. Knickerbacker Boyd, architect; treasurer, Wright D. Goss, chairman, Empire Brick & Supply Co.; executive, Dwight L. Hoopingarner.

Set Record for Tunnel Driving on New Cascade Tunnel

A new world's record for tunnel driving is claimed by A. Guthrie & Co. which firm holds the contract for the 8-mile "new Cascade tunnel" on the Great Northern R.R. 97 miles east of Seattle, Wash. In the month of August the 8 x 9-ft. pioneer bore at the west portal of this tunnel was advanced 937 ft., exceeding by 5 ft. the record made by Foley, Welsh & Stewart in a 31-day period on the Rogers Pass tunnel in British Columbia in 1915. The Rogers Pass drift, also a pioneer bore, was 8 x 7 ft. in section.

R. F. Hoffmark is general superintendent in charge of the Cascade tunnel work. The time of shooting on each shift throughout the month is given in the following table:

Date	Time of Shooting					Progress Daily	Progress Total
Aug. 1	9:00 P.M.	2:20 A.M.	7:35 P.M.	1:45 A.M.	7:40 A.M.	38	38
2	2:30 P.M.	7:45 P.M.	2:30 A.M.	.....	.....	23	61
3	8:25 A.M.	2:15 P.M.	7:55 P.M.	1:25 A.M.	7:35 A.M.	41	102
4	1:15 P.M.	7:05 P.M.	12:55 A.M.	7:10 A.M.	.....	32	134
5	1:30 P.M.	7:00 P.M.	1:20 A.M.	7:45 A.M.	.....	34	168
6	2:00 P.M.	7:50 P.M.	1:45 A.M.	7:35 A.M.	.....	28	196
7	2:15 P.M.	8:55 P.M.	3:15 A.M.	.....	.....	23	219
8	9:10 A.M.	3:15 P.M.	8:55 P.M.	3:40 A.M.	.....	28	247
9	9:50 A.M.	5:45 P.M.	2:15 A.M.	.....	.....	21	268
10	10:20 A.M.	6:25 P.M.	3:35 A.M.	.....	.....	23	291
11	11:15 A.M.	5:55 P.M.	12:15 A.M.	6:20 A.M.	.....	22	313
12	11:55 A.M.	6:15 P.M.	11:45 P.M.	6:05 A.M.	.....	29	342
13	11:45 A.M.	6:10 P.M.	12:20 A.M.	6:25 A.M.	.....	31	373
14	11:40 A.M.	5:45 P.M.	11:55 P.M.	6:35 A.M.	.....	27	400
15	11:25 A.M.	5:30 P.M.	11:20 P.M.	5:45 A.M.	.....	28	428
16	11:30 A.M.	5:00 P.M.	10:50 P.M.	4:25 A.M.	.....	31	459
17	9:55 A.M.	3:10 P.M.	8:15 P.M.	2:10 A.M.	7:45 A.M.	37	496
18	2:40 P.M.	8:05 P.M.	2:10 A.M.	7:40 A.M.	.....	31	527
19	2:15 P.M.	7:55 P.M.	2:15 A.M.	7:45 A.M.	.....	30	557
20	3:00 P.M.	11:05 P.M.	6:35 A.M.	.....	.....	25	586
21	11:30 A.M.	4:55 P.M.	10:15 P.M.	4:00 A.M.	.....	29	615
22	9:20 A.M.	3:00 P.M.	8:35 P.M.	2:55 A.M.	7:35 A.M.	36	647
23	1:05 P.M.	6:55 P.M.	2:15 A.M.	7:30 A.M.	.....	31	682
24	1:20 P.M.	7:15 P.M.	1:00 A.M.	7:15 A.M.	.....	28	710
25	12:25 P.M.	6:35 P.M.	12:40 A.M.	6:55 A.M.	.....	33	739
26	12:55 P.M.	6:45 P.M.	1:05 A.M.	7:10 A.M.	.....	26	765
27	12:45 P.M.	6:20 P.M.	12:45 A.M.	7:25 A.M.	.....	31	796
28	1:05 P.M.	6:55 P.M.	12:55 A.M.	7:15 A.M.	.....	33	829
29	12:20 P.M.	5:35 P.M.	11:30 P.M.	4:35 A.M.	.....	33	862
30	9:40 A.M.	3:00 P.M.	8:05 P.M.	1:10 A.M.	6:30 A.M.	36	898
31	11:20 A.M.	4:20 P.M.	9:35 P.M.	3:10 A.M.	7:45 A.M.	39	937

Consultants to Study Bridge Projects at San Francisco

The San Francisco Board of Supervisors after concluding a series of hearings extending over a month, at which presentation of 16 transbay bridge and tunnel projects were made, voted on Oct. 4 to employ "three bridge engineers of established reputation not affiliated with any project asking a franchise, to study the problem of bridging the bay, and to make such investigations and compile such engineering data and information as may be essential to enable this board and the people of San Francisco to determine the best type and location of a bridge to serve the interests of the community." The board also voted to name a committee of three members to go to Washington to consult with the War Department and other government agencies on the subject of bay bridges, and wired the War Department for an appointment for this committee.

Large Terminal for Jersey City

A 10-story freight terminal and storage warehouse, a refrigerating and ice-making plant and a fruit and vegetable market, all of reinforced-concrete construction, are being built in Jersey City, N. J., for the Seaboard Terminal & Refrigeration Co., at a cost estimated as nearly $5,000,000. The Ball Engineering Co., St. Louis, designed the plant, and the Blome-Sinek Co., Chicago, has the contract.

Public Works in Haiti Expanding

With the improvement in financial conditions in the republic of Haiti which has come about in recent years, the republic is about to undertake considerable public work, both municipal and national. Since 1917 this work has been under the supervision of an officer of the Corps of Engineers of the U. S. Navy with civilian engineers and superintendents from this country. With the expanding program the Navy is now looking for a few men for this service.

Canadian Good-Roads Association Meets in Edmonton

The thirteenth annual convention of the Canadian Good Roads Association was held at Edmonton, Alberta Sept. 28-30 with an attendance of about 150, including government highway commissioners and representives of good roads organizations in the nine Dominion provinces. The question of federal assistance for road making was discussed at some length and resolutions were adopted calling for the re-establishment of the federal-aid system and the early completion of the trans-Canada highway.

William Findlay of Toronto gave an address advocating the marking of highways at the time of construction by the government rather than leaving the work to private motor associations. A. W. Campbell, chief commissioner of highways for Canada, strongly favored the proposal for federal aid and expressed the hope that the amount of the previous grant would be largely increased. Under the provisions of the act $46,901,000 has been expended in seven years. R. A. C. Henry, director of the bureau of economics of the Canadian National Rys., presented a paper on the "Responsible Body for Road Building," contending that better results were secured when road making and maintenance were undertaken by public bodies rather than by private corporations.

The following officers were elected: president, George S. Henry, Ontario Minister of Highways; vice-presidents, John Oliver, premier of British Columbia, and P. G. Black, Nova Scotia Minister of Highways; and secretary-treasurer, George A. McNamee, Montreal.

College Teachers Attend School at P.C.A. Laboratory

Representatives of 25 colleges attended a short course of normal instructions given from Sept. 7 to 11 by the Portland Cement Association at its laboratory in Chicago. Twelve sessions were held, including lectures, demonstrations, problems and inspection trips. The course was given in response to a request from engineering instructors for co-operation in the correct teaching of design and control of concrete mixtures.

The following outline indicates the scope of the course: (1) Fundamental factors of concrete mixtures, (2) selection and testing of aggregates, (3) proportioning concrete, (4) field control of concrete, (5) effect on concrete of various factors, and (6) scope and arrangement of college courses in concrete design and testing. Various types of construction in and near Chicago were visited to observe the application of the methods taught to field conditions. Twenty states were represented by those who attended the course. The course was conducted under the direction of J. W. Kelly, assisted by other members of the staff of the Portland Cement Association, including Prof. Duff A. Abrams, F. R. McMillan and H. F. Gonnerman.

Short Railway Line Approved in Mississippi

The New Orleans Great Northern Railway Co. has been authorized by the Interstate Commerce Commission to construct an extension of its lines from Nogan, Miss., to a terminal site on the west bank of the Pearl River in the city of Jackson, Miss., a distance of 6.65 miles. The railroad company has owned the right-of-way for a number of years, but has been unable to complete the line into Jackson. The cost is placed at $623,000.

Sectional Meeting of World Power Conference Held at Basel

The quantity and the effectiveness of power development is certain to increase as a result of the meetings held under the auspices of the World Power Conference, in the opinion of O. C. Merrill, who just has returned from the Basel meeting where he headed the American delegation. In the statement given out on his return Mr. Merrill says, in part:

"The second meeting of the World Power Conference was held at Basel, Switzerland Aug. 31-Sept. 8, and was attended by some 700 representatives from 38 different countries.

"The Conference was organized in 1923, and held its first 'plenary' session in London in 1924 with representatives of 42 countries in attendance.

"The Basel meeting was primarily a European meeting, the largest delegations being from Switzerland and Germany. The United States, however, had ten delegates present. At the request of the Swiss Government that the United States send an official delegate, Mr. Merrill, chairman of the American Committee, and American member of the International Executive Committee was designated by the President as delegate to the conference in behalf of the United States.

"The program of the Basel meeting covered five main topics: Utilization of Water Power, and Inland Navigation; Exchange of Electrical Energy Between Countries; The Economic Relation Between Electrical Energy Produced Hydraulically and Electrical Energy Produced Thermally: Conditions Under Which the Two Systems Can Work Together with Advantage: Electricity in Agriculture; and Railway Electrification, under each of which papers were presented by some member of the American Committee. More than 100 papers in all were submitted from the various countries. All papers received in time were printed for distribution, were abstracted by the Swiss 'general reporters,' and the abstracts printed in English, French and German. No papers were read in full at the meetings, but the abstracts of the special subject under discussion were presented by the reporters, and general discussion followed. The sessions were well attended, there was great interest in and active discussion of the various subjects. The Swiss Federal Railways placed special trains at the disposition of the delegates for an inspection of a portion of their system and of the power developments in the vicinity of Rheinfelden and of the St. Gothard Pass. The various social functions and the opportunity afforded to become acquainted with the representatives of so many countries formed no small part of the value of the conference.

"The affairs of the World Power Conference as a whole are handled through the medium of an International Executive Committee consisting of one member from each of the countries which have organized national committees. At the meeting of the committee in Basel a draft of a proposed constitution for a more definite organization of the conference was adopted for submission to the various National Committees for ratification. Plans were also perfected for a sectional meeting in London in 1928 to be devoted exclusively to a consideration of the fuel problem in its relation to power development. The 1929 meeting of the International Executive Committee will be held at Como, Italy, in conjunction with the celebration by Italy of the Volta centenary. The next plenary session will be held in 1930, in Italy if the Italian Committee can undertake its organization. Otherwise the meeting is likely to be held in the United States."

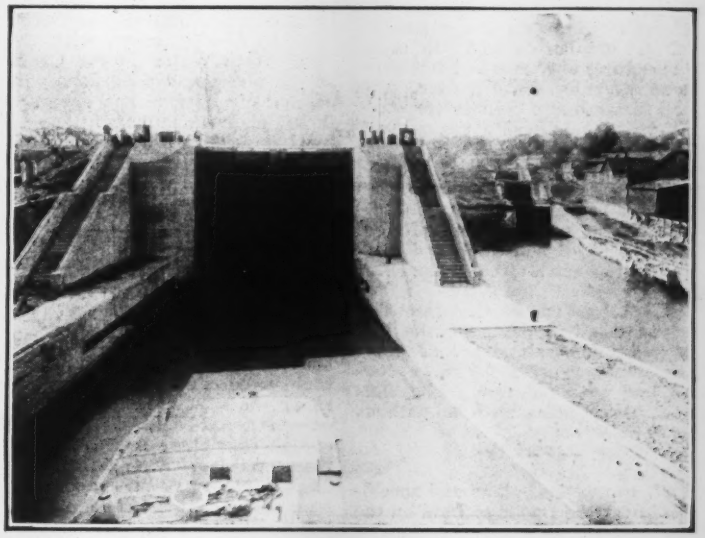
Would Ask 175-Ft. Clearance Under Columbia River Bridge

A clearance of 175 ft. is recommended to the city of Portland, Ore., by C. E. Grunsky as the minimum which should be required if the proposed toll bridge across the Columbia River between Rainier, Ore., and Longview, Wash., is approved.

Mr. Grunsky's report, which goes exhaustively into various phases of the project, points out that the clearance of 155 ft. suggested by the proponents of the structure should not be accepted and also recommends that increases should be required in the channel widths they propose. The port development committee which is handling the matter for the city said in making the report public, that it dealt with secondary phases of the situation and that the first question is whether any bridge should be approved across the Columbia River below the mouth of the Willamette River.

The proposal to build the Rainier-Longview toll bridge has been agitated for about three years and a bill to grant a permit for it was introduced in Congress at the last session but was not brought to a vote.

ERIE CANAL CENTENNIAL CELEBRATED



THIS week the centennial of the completion of the Erie Canal across New York State from Lake Erie, at Buffalo, to the Hudson River, at Troy, is being celebrated in a number of cities along its route. The formal opening actually took place in October, 1825, when Governor Clinton made a triumphant trip through the canal from Buffalo to New York bringing two casks of water from Lake Erie to be poured into the ocean at New York. The canal was opened for traffic in 1826.

Little remains now of the original canal. Soon after it was built increasing traffic made it necessary to deepen and enlarge it, and in recent years it has been converted into a barge canal. This new canal follows the route of the old canal generally, but rivers which the old canal paralleled have been canalized and all the locks have been replaced by much larger ones, frequently being situated at new locations.

The illustration is of lock No. 2 of the Barge Canal at Waterford, N. Y. It shows the contrast between the old and new canal structures; the new lock with a lift of 33½ ft. replacing three locks in the old canal. The five new locks at Waterford have a total lift of 169 ft. The total distance from the Hudson River at Troy to where the canal enters the Niagara River at Tonawanda is 339 miles.

WASHINGTON NOTES

CONTINUED difficulties on private irrigated enterprises and on some of the federal reclamation projects at a time when agriculture generally is recovering is further proof to Dr. Elwood Mead, the Commissioner of Reclamation, that settlement and farm development must be carried out along certain definite and business-like lines. He is continuing to insist that legislation to that end is essential if the increasing criticism in the East is to be met successfully and if extension of the irrigated area is to be secured.

"It is my belief," says Dr. Mead, "that the profits of intensive agriculture are destined to be greater in the future than they have been in the past. If we provide for the preparation of the land for cultivation, as we have provided for the building of the canals, and if we require the land owners to join in some co-ordinated plan of subdivision and colonization, we can create an agriculture that will be highly profitable and which will support the type of farm communities that makes rural life attractive."

Too much irrigated land is in the hands of those without capital, Dr. Mead points out. "They lack the money needed to clear and level the land and equip farms. Many do not expect to do this. They plan to sell. In order to pay operating expenses and construction costs we must have settlers who are good farmers and their farms must be equipped for intensive agriculture. To insure these things additional legislation is necessary.

"The non-payment of charges on certain projects is due solely to unfit settlers and the lack of any co-ordinated plan on the part of mortgage and trust companies to settle the abandoned farms."

While Dr. Mead admits that the writing off of the bad debts of the last twenty years has stimulated demands from some water users for more concessions and more deferments, he feels sure that these pleas will be without avail.

FINAL approval of plans and specifications for the Coolidge Dam on the San Carlos Indian reclamation project in Arizona and authorization of advertisements for bids for its construction was announced at the Interior Department Sept. 23.

Plans provide a multiple-dome type. To a considerable extent the specifications are based on the American Falls Dam on the Minidoka irrigation project in Idaho and the Gibson Dam on the Sun River irrigation project in Montana being constructed by the Reclamation Bureau of the Interior Department. The specifications have already been approved by a board of consulting engineers.

The Coolidge Dam is the principle irrigation structure on the San Carlos project, which is designed to irrigate over 100,000 acres of land in the Gila River valley in Arizona, 50,000 of which will include lands belonging to the Indians in the Gila River Indian Reservation.

The construction of the dam was authorized by Congress at a cost not exceeding $5,500,000.

Organization of New York City Plan and Survey Committee

The organization of the Committee on Plan and Survey of New York City has been announced by Mayor Walker. The chairman is Morgan J. O'Brien, an ex-judge, and the secretary, Joseph A. Warren, Commissioner of Accounts, New York City. The chairman of some of the committees are: Housing, Frederick H. Ecker, vice-president of Metropolitan Life Insurance Co.; highways and bridges, Albert Goldman, commissioner of plant and structures; sanitation and harbor pollution, Dr. Thomas Darlington, ex-commissioner of health; traffic, Dr. John A. Harriss, director Fifth Avenue Association and former honorary deputy police commissioner; port terminal facilities, John J. Fitzgerald, lawyer, ex-chairman appropriations committee, U. S. House of Representatives.

Two Companies Accept Conditions for St. Lawrence Development

Both the Frontier Corporation and the American Super-Power Corporation have filed acceptances with the New York State Water Power Commission of the terms and conditions which the present commission has enumerated as those under which it will issue a license for the development of power on the St. Lawrence River. A statement of these conditions was given in *Engineering News-Record*, Sept. 30, p. 555.

Concrete Reinforcing Institute Makes a National Campaign

At the semi-annual meeting of the Concrete Reinforcing Steel Institute, held at French Lick, Ind., recently, it was voted that a promotion expert should be appointed to carry out work on a national basis. The committee on engineering practice, through its chairman, William F. Zabriskie, Detroit, Mich., presented a report covering standard building code recommendations for reinforced concrete. After discussion which resulted in some amendments the report was adopted. Reports were made also by the committee on engineering, selling and cartage costs, and the committee on foreign steel. This latter showed the steps taken on the east and west coasts in regard to imports of foreign steel and the steps now being taken at Washington to restrict this competing product. Later, word was received that foreign steel will not be permitted in the New York subway, which work will require approximately 400,000 tons of steel during the next two years.

Other reports were made by committees on membership, grade of steel and standard sizes, standard practice, mill support and rail steel. In an address reviewing conditions on the Pacific Coast, illustrated with motion pictures and lantern slides, E. L. Soule, San Francisco, dwelt upon the character of reinforced-concrete construction before and after the San Francisco earthquake and fire and showed what restrictions were placed upon building projects by existing ordinances in that city and Los Angeles. Another illustrated address was on the development of concrete reinforcement, by A. E. Lindau, Chicago. Announcement was made of the new California Reinforcing Steel Institute, with offices at Los Angeles and San Francisco, which has been organized along lines similar to that of the national institute.

RANDOM LINES

A Few New Recruits

(199) *Jazz Engineers*—

SAVE THIS TICKET Nº 4352
IT MAY BE THE LUCKY NUMBER
When Terpsichore Commands, Dance to Sully's Seven-Ace Orchestra, Jazz Engineers Supreme at the
TIP TOP ROOF on South Dixie
CONGENIALITY WELCOMES YOU
COOL BREEZES REFRESH YOU

(200) *Seasoning Engineer*—A gentleman, according to *The Timberman*, who is in charge of the dry kilns of the Johnson Lumber Co., of Reedsport, Ore.

(201) *Culinary Engineer*—"Jean Chef, C.E. Barna's is ravished to announce that the degree of Culinary Engineer has been bestowed on the master of gastronomics who presides over its kitchens."—An advertisement in *The New Yorker*.

(202) *Organ Engineer* — Herman Roehl, who, says the Hartford *Courant*, has just completed the removal of the pipe organ from a church in that city.

(203) *Facial Engineer* — A new profession, according to an editorial in Pop Curtis' Philadelphia *Ledger*. Only beautifiers of the female visage qualify. Mere barbers don't belong.

(204) *Communication Engineer*—Real vocation, selling radio supplies.

(205) *Moral Engineer*—A new variety introduced to the public by the president of a well-known mid-West university, who also writes syndicated newspaper articles on uplift topics. He says in one such article, "The man who sets out to exercise an intelligent control over his habit is fairly insured against freakishness if he follows the *moral engineer* rather than the moral exhorter." And as if to prove that the new term is not a misprint he adds, "William James is one of the best consulting engineers I know."

Engineering Societies

Calendar

Annual Meetings

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York, N. Y.; Annual Convention, Philadelphia, Pa., October 4-9, 1926.

AMERICAN PUBLIC HEALTH ASSOCIATION, New York City; Annual Meeting, Buffalo, N. Y., Oct. 11-14, 1926.

AMERICAN ASSOCIATION OF STATE HIGHWAY OFFICIALS, Washington, D. C.; Annual Convention, Pinehurst, N. C., Nov. 8-12, 1926.

AMERICAN SOCIETY FOR MUNICIPAL IMPROVEMENTS, St. Louis, Mo.; Annual Meeting, Washington, D. C., Nov. 8-12, 1926.

FIFTH ANNUAL ASPHALT PAVING CONFERENCE, AUSPICES ASPHALT ASSOCIATION, New York City, Washington, D. C., Nov. 8-12, 1926.

NATIONAL COUNCIL OF STATE BOARDS OF ENGINEERING EXAMINERS, Columbia, S. C.; Annual Convention, Philadelphia, Pa., Nov. 15-16, 1926.

HIGHWAY RESEARCH BOARD, OF NATIONAL RESEARCH COUNCIL, Washington, D. C.; Annual Meeting, Washington, D. C., Dec. 2 and 3, 1926.

The North Atlantic Section of the American Society of Agricultural Engineers will meet at State College, Pa., Oct. 11 to 13. S. H. McCrory, chief of the Division of Agricultural Engineering of the U. S. Department of Agriculture, will speak on "Results of the Farm Equipment Research Survey"; L. G. Heimpel, professor of agricultural engineering at Macdonald College, Quebec, on "Dilution of Crankcase Oil in Kerosene Burning Engines," and F. L. Fairbanks, assistant professor of rural engineering, New York State College of Agriculture, will discuss "Farm Building Ventilation." There will be other talks on agricultural engineering education, farm power, farm home utilities, rural electrification, farm buildings. The attending engineers will visit the Pennsylvania State Experiment Station.

The National Council of State Boards of Engineering Examiners will hold its annual convention in Philadelphia, Pa., Nov. 15 and 16, 1926.

The National Association of Railroad and Utilities Commissioners will hold its annual convention in Asheville, N. C., Nov. 9-12, 1926.

Personal Notes

CHARLES S. CHURCHILL, vice-president in charge of purchases, real estate and valuation of the Norfolk & Western Ry., retired Sept. 30, after nearly 40 years of service with the company. Mr. Churchill is a native of New Britain, Conn., and a graduate in civil engineering from Yale University in 1878. During the next 10 years he was employed largely on railroad work and in 1888 became engineer in charge of preliminary and location surveys on the Ohio extension of the Norfolk & Western Railway System. Since that time he has been continuously with the Norfolk & Western, becoming chief engineer in January, 1903. In 1913 he was placed in charge of valuation work on the Norfolk & Western as chairman of the railroad's committee. The following year he was appointed assistant to the president and in 1918 was elected vice-president. Mr. Churchill has served as a member of the special committee of the American Society of Civil Engineers on railroad valuation and also as a director and vice-president of the society. He is a charter member of the American Railway Engineering Association and one of its past-presidents.

GEORGE F. SCHLESINGER, director of highways and public works for the state of Ohio, has been reappointed for the second term of a year, dating from Aug. 10, 1926.

W. P. NORRIS, who has been employed as a senior project engineer by the department of Public Works of the state of Nebraska, has accepted a position as county engineer for Page County, Iowa. Due to recent floods in southwestern Iowa, Page County is planning a large program of construction and repair on highway bridges.

COLONEL F. A. MOLITOR, member American Society of Civil Engineers, consulting engineer, of 90 West St., New York City, has been appointed by the International Committee of Bankers of Mexico, a member of the valuation of damages commission. Colonel Molitor leaves for Mexico City in early October to undertake this commission, which is expected to occupy about two months.

GEORGE R. FULTON has recently joined the organization of Stone & Webster, Inc., as an engineer in the power division. Mr. Fulton was assistant chief engineer with the Galveston-Houston Electric Ry. Co.

ALBERT B. ALSOS is now an engineer in the power division of Stone & Webster, Inc. Mr. Alsos, formerly a first lieutenant in the Norwegian navy, has been with the Bethlehem Shipbuilding Corporation as engineer in the power machinery division.

Obituary

HENRY BEECHER WOOD, formerly engineer in the state public works of Massachusetts and consulting engineer on many projects in the state and in the city of Boston, died Sept. 26 at his home in Belmont, Mass., aged 72 years. Mr. Wood was born in Woburn, Mass., and graduated from Massachusetts Institute of Technology in 1876. For some years he was employed in government service as a surveyor in the Mississippi River developments. From 1885 to 1901 he was connected with Boston city departments and was responsible for the planning of many streets and parks. He also served in the water and sewer departments and for six years was executive engineer in charge of seven consolidated city departments. Later as engineer in the state department of public works he had a prominent part in the Taunton inland water route and in the Mt. Tom development.

JAMES W. HENDERSON, construction engineer, Washington, D. C., was almost instantly killed Sept. 30 when the car in which he was riding crashed into a trolley pole in the city. Mr. Henderson was a major of reserves in the Construction Division of the army. Since the World War he had been engaged in construction of Chinese government buildings in Peking, China.

ALFRED CRAVEN, formerly chief engineer of the New York City Public Service Commission under whose administration the dual subway rapid-transit system was planned and built, died Sept. 30 at his home in Pleasantville, N. Y., aged 80 years. Mr. Craven was born at Bound Brook, N. J. As he came of a family with a long line of naval men, he went to the U. S. Naval Academy, graduating in 1867 and then spent some years in the U. S. Navy. In 1871 he joined the California Geological Survey and later was engaged in irrigation work in the Sacramento and San Joaquin valleys, then went into private practice in Virginia City and was connected with the development of the famous Comstock Lode. On this work he was connected with the design of the Sutro tunnel made to drain some of the deep mines. In 1884 he returned East to become division engineer of the Croton Aqueduct. After fifteen years on the Croton Aqueduct he was in 1895 placed in charge of the building of the Jerome Park Reservoir, as division engineer, but retired from the work when changes made over his protest were overruled. In 1900 when the first New York City subway work was begun, Mr. Craven was appointed division engineer on the staff of the Rapid Transit Commission in charge of construction of that portion of the subway from 41st St. and Park Avenue to 104th St. He was appointed deputy chief engineer of the Rapid Transit Commission in 1904, acting chief engineer in 1907 and chief engineer in 1911. Under his administration as chief engineer the New York dual subway system was in great part brought to completion so that his direction of that great project was an important engineering accomplishment. In 1915 Mr. Craven was appointed by the Secretary of the Navy as one of the two representatives of the American Society of Civil Engineers on the Naval Consulting Board. In 1916 he retired as chief engineer of the Rapid Transit Commission to become consulting engineer to the Public Service Commission and its successor, the Transit Construction Commission. In 1920 he retired as consulting engineer and had lived since then at Pleasantville, N. Y. He served as vice-president of the American Society of Civil Engineers in 1916.

Construction Equipment and Materials

A SECTION DEVOTED TO WHAT THE MANUFACTURER IS DOING FOR THE ENGINEER AND CONTRACTOR

Large Merger of Cement Producers Announced

Pennsylvania-Dixie Cement Corp. New York City has been incorporated under the laws of the state of Delaware to acquire the business and property of the Pennsylvania Cement Co., Dexter Portland Cement Co., Dixie Portland Cement Co., and Clinchfield Portland Cement Corp. The resulting corporation will be one of the largest companies in the cement producing industry owning 7 plants with an aggregate production capacity of 10,000,000 bbl. per year. In addition the corporation through subsidiaries will produce and sell sand and gravel, limestone, tile, and other cement products. New financing in the forms of 300,000 shares of no par value common stock, $13,000,000 in first mortgage sinking fund 6 per cent bonds and $7,215,300 in convertible 7 per cent cumulative preferred stock has recently been undertaken by the new corporation to provide additional working capital.

The management of the new company will be composed of men identified with the predecessor companies: Richard Hardy, chairman of the board, John A. Miller, president and George Kilian, secretary and treasurer.

The locations of the seven plants of the company, with their capacities, are:

Nazareth Pa., Plant No. 1...	1,300,000 bbl.
Nazareth Pa., Plant No. 2...	1,100,000 bbl.
Bath, Pa.	1,940,000 bbl.
Portland Point, N. Y.....	1,060,000 bbl.
Richard City, Tenn.....	2,000,000 bbl.
Kingsport, Tenn.....	1,500,000 bbl.
Clinchfield, Ga.	1,100,000 bbl.
Total	10,000,000 bbl.

Portland Cement Association Makes New Appointments

Effective Oct. 1, the Portland Cement Association, 33 West Grand Ave., Chicago, announces a number of new appointments to its general office staff.

C. R. Ege, who has been with the association 10 years and manager of the highways bureau since 1920, has been appointed manager of the advertising and publications bureau to succeed H. C. Campbell, resigned. Mr. Ege is an associate member of the Am. Soc. C. E., served as treasurer and is now president of the Highway Industries Association. W. E. Hart has been appointed manager of the highways and municipal bureau, which was formerly the highways Bureau. Mr. Hart is also an associate member, Am. Soc. C. E. and member of the American Concrete Institute. He has been with the association nine years and for four years has been manager of the structural bureau. G. S. Eaton has been appointed assistant manager, advertising and publications bureau. T. J. Harris has been appointed manager, general education bureau.

F. R. McMillan has been appointed manager of the structural and technical bureau, formerly known as the structural bureau. Mr. McMillan is a member of the Am. Soc. C. E. and has been associate engineer with the Research Laboratory of the association for two years, prior to which he was engaged in consulting work at Minneapolis. He has made numerous contributions to engineering literature, based on his research work.

Manufacturers Plan to Exhibit at Southwest Water Works Meeting

The following members of the Water Works Manufacturers Association have already made application for exhibit space at the coming convention of the Southwest Water Works Association to be held at Shreveport, La., October 11-15:

R. D. Wood & Co.
Hersey Mfg. Co.
Pittsburgh Meter Co.
A. P. Smith Mfg. Co.
Federal Meter Co.
Rensselaer Valve Co.
American Cast Iron Pipe Co.
Paradon Engineering Co.
Neptune Meter Co.
Mueller Co. Inc.
McWane Cast Iron Pipe Co.
Columbian Iron Works
The Pitometer Co.
Sullivan Machinery Co.
Wallace & Tiernan Co. Inc.
Birch Mfg. Co.
Layne & Bowler Mfg. Co.
H. W. Clark Co.

Business Notes

R. E. McKee, former assistant manager of the tie and timber sales department, Long-Bell Lumber Co., at the home office in Kansas City, Mo., has been transferred to the position of manager of the New York sales office. Mr. McKee has been with the company 16 years, the last 7 of which have been in the tie and timber department.

Link-Belt Co., Chicago, announces the opening of a new branch office in Utica, N. Y. This is the company's 34th office and the third within the state of New York, and is to be devoted especially to the sale of silent chain and roller chain. It will be in charge of F. P. Hermann, Jr., formerly in the New York office of the company.

Carl G. Schluederberg has been appointed general manager in charge of sales engineering and manufacturing of the George Cutter Co., South Bend, Ind. This company is a subsidiary of the Westinghouse Electric Co. in which street, industrial and commercial lighting equipment and battery chargers are manufactured. Mr. Schluederberg succeeds Warren Ripple, vice president and treasurer of the George Cutter Co., who has resigned on account of illness. Mr. Schluederberg has been with the Westinghouse company continuously since 1910 and was also with them prior to that time, immediately after his graduation from Cornell University in 1902. He has made industrial surveys for the company in many of the principal countries of the world. He is a member of the N.E.L.A., and A.I.E.E., the principal chemical societies and other clubs and organizations.

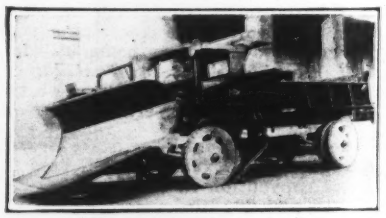
Ellis K. Phelps, formerly of Wallace & Tiernan Co., has joined the staff of the Paradon Engineering Co., Long Island City, N. Y. Mr. Phelps will take charge of sales and service of Paradon chlorinators in the New England States and in the state of New Jersey.

Chicago Pneumatic Tool Co., New York City, announces the establishment of a sales and service branch in El Paso, Tex., to serve its clientele in southwest Texas, New Mexico, eastern Arizona, and northern Mexico. E. J. Coughlin is in charge of the new branch.

New Developments

Gas-Electric Snow Plows to Keep Bus Routes Open

Gas-electric drive, introduced two years ago and in use today in many buses throughout the United States, is to be applied this winter to the propulsion of snow plows. The Philadelphia Rural Transit Co. is obtaining fifteen snow plows from the Walters Motor Truck Co., Long Island City, with electric drive furnished by the General Electric Co. The plows are mounted on



the front of the gas-electric trucks and are demountable so as to make the trucks available for other service during the summer.

An experimental unit placed in service last winter in Philadelphia used an electrical equipment, duplicating those of the buses, although the engine was considerably larger. It was known that the equipment was not of sufficient capacity, but it was felt that such tests would assist in the proper selection of equipment. In the new truck-plow the electrical equipment will be of somewhat larger capacity and more suited for the larger engine. The generator, driven directly by the gasoline engine, will be self-excited and the engine

speed will not vary much with wide open throttle between low truck speed and free running. The motors are fitted with commutating poles and are of the regular series railway type.

The chassis is a special four-wheel drive machine, a motor driving each axle through a differential. A speed of 25 to 30 m.p.h. and a drawbar pull of approximately 10,000 lb. are available. The front and rear axles are made with a patented automatic locking differential which is claimed to give such a positive drive to all four wheels that the need of skid chains is practically eliminated. The motor is a 100-hp. unit.

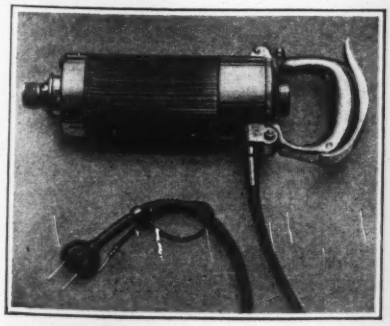
An advantage is pointed out in connection with speed and power changes over the gasoline truck. When removing snow with the latter a change of gears must frequently be employed when varying depths are encountered. On the electric drive the plowing speed is automatically changed with the change in torque demand. This is claimed to result in greater speed and efficiency, since the engine can be used almost continuously.

Surface Hardener in Colors for Concrete Floors

A new concrete floor treatment which produces mottled colors on plain cement surfaces, at the same time making the floors dust-proof and wear-resisting, is the newest product of the Master Builders Co., Cleveland, Ohio. The new product is known as "Dycrome" and is a chemical compound. By chemical reaction with the cement, a variety of permanent tints and colors is obtained. Either a single color or a combination of several colors is possible. The intensity of the colors varies according to the degree of chemical reaction between the Dycrome and cement, giving a cloudlike effect. The Dycrome is applied with a brush to concrete surface already laid. Dycrome is supplied in powder form in 10-lb. pails, 50-lb. pails and 100-lb. drums. One pound is sufficient for two treatments of 40 to 45 sq.ft. of surface.

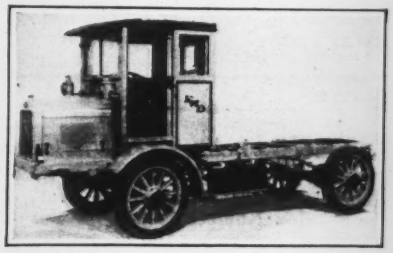
Improvements Increase Efficiency of Electric Hammer

A new model electric hammer known as Model 26 is being manufactured by the Fermot Co., 200 Broadway, New York City, as an improvement over its Model 25. The chief characteristics of the new model are an increased efficiency and much larger capacity in drilling. The feeding cable in the new model is attached to the body of the hammer instead of being attached to the handle as in the previous model, thus eliminating the hindrance opposed by the weight of the cable to the free movements of the hand of the operator. The aluminum housing on the old model has been eliminated in order to obtain a quicker cooling of the coil and incidentally has reduced the vibrations and humming to such an extent that the hammer is claimed to be practically noiseless. The switch on the handle is operated by the pressure of the thumb instead of by the palm of the hand as was formerly the case. The regulating lever is substituted by a revolving knob of tempered steel. Finally the control of the feeding of the hammer is claimed to be more accurate than with the old model. The hammer goes under the trade name of "Simbi" and is marketed by the Rawlplug Co., Inc., 66 W. Broadway, N. Y. City.



Truck of 1½-2 Ton Capacity Added to Company's Line

After a year's development in the United States and South America, the model H, 1½-2 ton four-wheel driven truck, has just been placed on the market by the Four Wheel Drive Auto Co., Clintonville, Wis. It is constructed along the same general lines as the company's standard model B, but has the motor in front of the dash instead of under the seat. The overall length



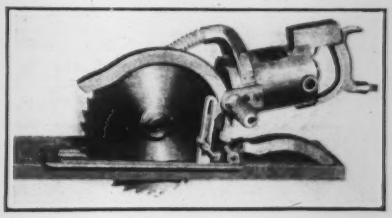
is 202 in., providing a body space back of the seat of 9 ft. 10 in. The weight of the chassis is 5,300 lb. A wheel base of 121 in. is used, making possible a turning radius of 22 ft. 6 in. A speed of 22 m.p.h. on 36x5 in. solid tires is possible. The engine is a four cylinder, four cycle Wisconsin model SU with a peak horsepower of 50 at 2,000 r.p.m. The steering gear is on the left-hand side with the control levers in the center. There are four speeds forward and one reverse.

Precast Cinder-Concrete Slabs for Small Buildings

A building material unit made of cinder-concrete and wiremesh reinforcement and cast in the shape of boards 1 ft. wide, 3 in. thick and from 8 to 12 ft. long, has been used on a number of small residences and garages around New York City. It is being produced by the Non-Burnable Building Products Co., Inc., 474 West 142nd St., New York City. Two types of slab have been patented, one using double mesh reinforcement, and the other using the same reinforcement in addition to an air space. The slabs are erected vertically, their length being predetermined by the ceiling height. The reinforcement is allowed to extend on either side of the slab so that the separate units may be bonded together. The cracks between the units are grouted after erection. Advantages claimed are saving in floor space, inflammable construction, ease of erection, and strength.

Electric Hand Saw

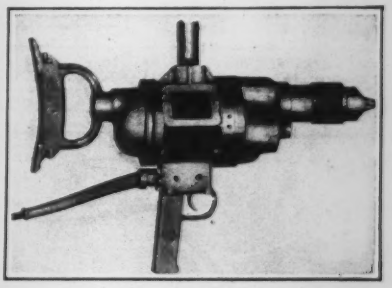
An electric hand saw, manufactured by the Wodack Electric Tool Corp., 23 S. Jefferson St., Chicago, is an electric tool weighing 24 lb. and fitted with a motor large enough to drive an 11-in. circular saw. It is operated from the



ordinary electric light socket. The saw is fitted with a depth gage, so it is only necessary to cut to the exact depth of a board or box cover, thereby preventing injury to contents of boxes when opening them. It has a special adaptation on construction work in the form building and miscellaneous sawing.

New Portable Electric Drill Uses Ball Bearings

The most recent product of the Black & Decker Co., Towson, Md., is a ball bearing electric drill designed to use either carbon steel or high speed steel bits for drilling holes up to ⅝ in. in steel or as large as 2 in. in wood. The drill is said to be ideal for use with spring expanded cylinder hones. For positive set hones the company's ⅝-in. heavy duty drill is recommended. The pistol grip and trigger switch have been improved on this model by the use of a two-pole switch. The overall length of the new drill has been reduced



to a minimum, so that drilling in close quarters is made easier. A patented chuck-key holder has been built integral with the breast plate, insuring that the key will always be with the drill. The no-load speed is 400 r.p.m., while the drill weighs 17½ lb. A 110-volt lighting circuit is used for power.

Engineering News-Record Statistics of the Construction Industry

Oct. 7, 1926 — *in the United States* — Vol. 97, No. 15

Engineering News-Record CONSTRUCTION COST Index Number (1913 = 100)

MONTHLY

January, 1925 to Date

October, 1926	**209.80**
September, 1926	208.30
October, 1925	205.35
Peak, June, 1920	273.80
1913	100.00

1925

Jan.	210.40	May	207.20	Sept.	202 10
Feb.	209.70	June	204.60	Oct.	205.35
March	210.20	July	204.60	Nov.	205.95
April	209.55	August	204.60	Dec.	205.95

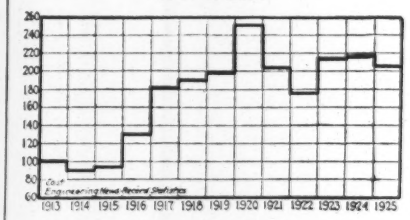
1926

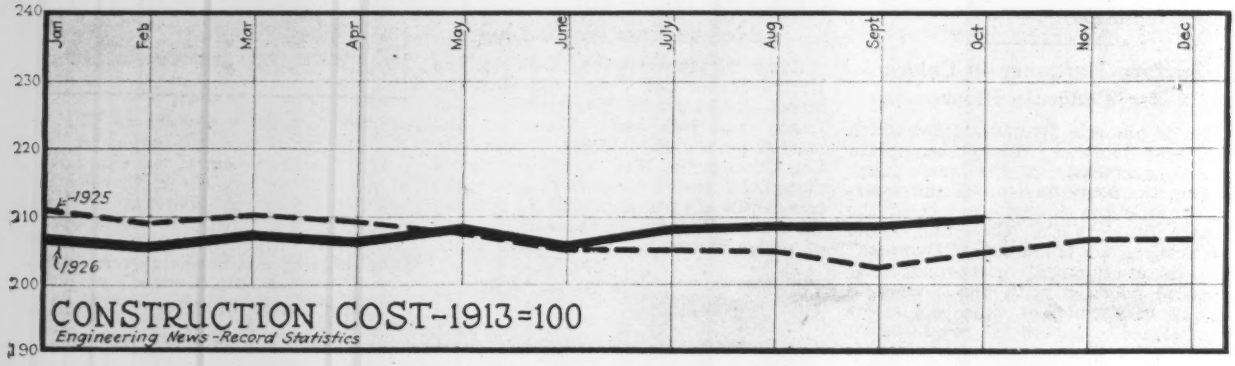
Jan.	207.15	Mar.	207.65	May	207.30
Feb.	206 55	April	207.05	June	204.80
July	207.80		August	208. 30	

ENGINEERING NEWS-RECORD'S Construction Cost Index Number is 0.7 per cent above the September level, owing to strong upward tendency in structural material. The average rate for common laborers is 55c. per hr. for the entire country as compared with 55½c. one month ago and 54c at this time last year. Thus, general construction cost is 2 per cent above October, 1925, 23 per cent under the peak and 109 per cent above the 1913 level.

YEARLY

1913 to 1925





Engineering News-Record CONSTRUCTION VOLUME Index Number (1913 = 100)

MONTHLY

January, 1925 to September, 1926

September, 1926	**227**
August, 1926	252
September, 1925	262
Peak, August, 1925	266
1913	100

1925

January	141	May	209	September	262
February	145	June	214	October	233
March	161	July	178	November	194
April	211	August	266	December	206

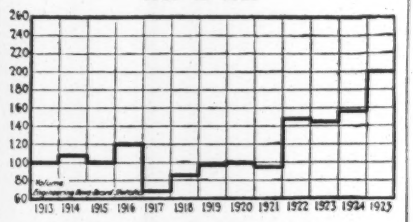
1926

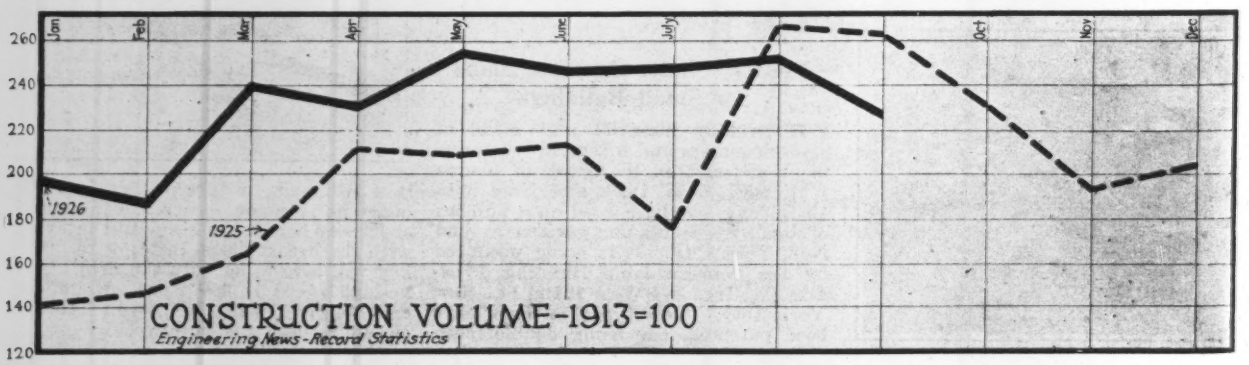
Jan.	198	Mar.	240	May	254
Feb.	187	April	233	June	246
July	248				

ENGINEERING NEWS-RECORD'S Construction Volume Index Number is 227 for the month of September and 201 for the whole of 1925, as against 100 for 1913. This means that the actual volume of contract letting in 1925 (not the mere money-value of the contracts let that year) is 101 per cent above the volume for 1913. The monthly volume number, 227 for September, 1926, contains the increment of construction and indicates the rate at which contracts are being let as compared with 1913 awards.

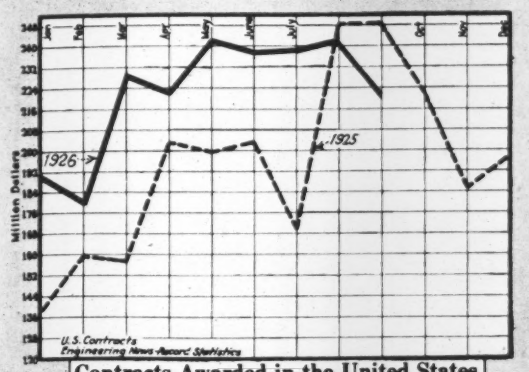
YEARLY

1913 to 1925

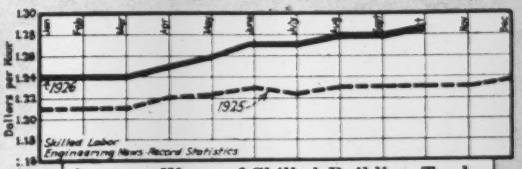




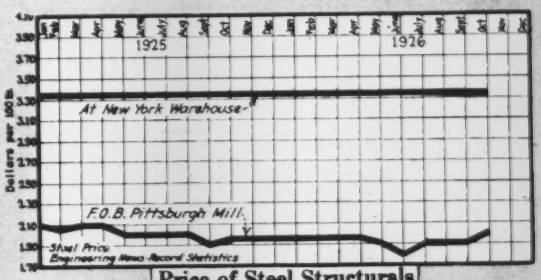
Monthly Statistics of the Construction Industry



Contracts Awarded in the United States
Reported in E. N.-R.

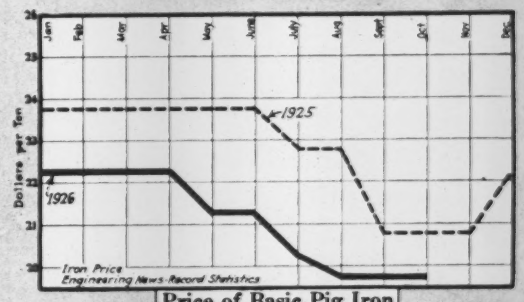


Average Wage of Skilled Building Trades
Bricklayers, Carpenters and Steel Erectors

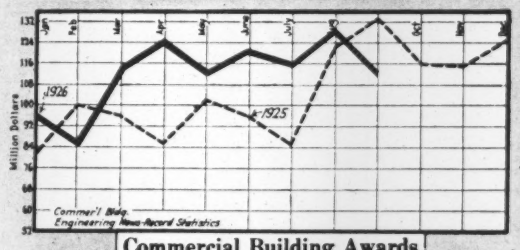


Price of Steel Structurals
Shapes 3-In.; Plates ¼-In.

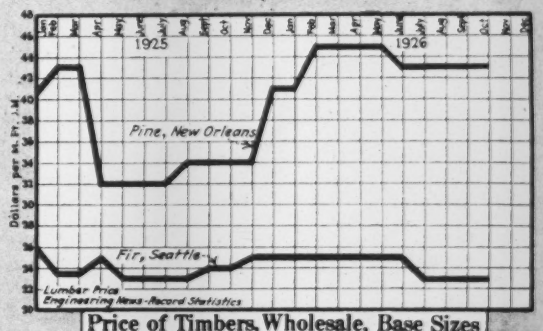
Industrial Building Awards
$40,000 and Over



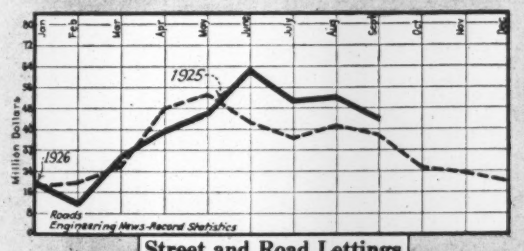
Price of Basic Pig Iron
F.o.b. Pittsburgh



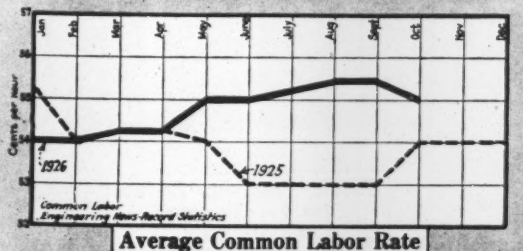
Commercial Building Awards
$150,000 and Over



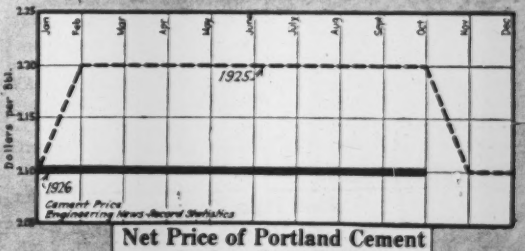
Price of Timbers, Wholesale, Base Sizes
Car Lots to Contractors



Street and Road Lettings
$25,000 and Over

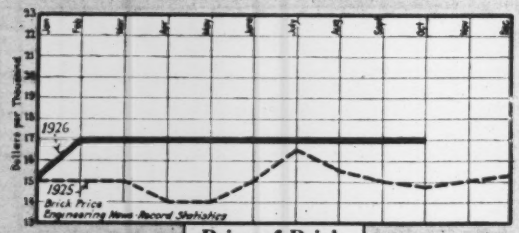


Average Common Labor Rate
Pick and Shovel Men

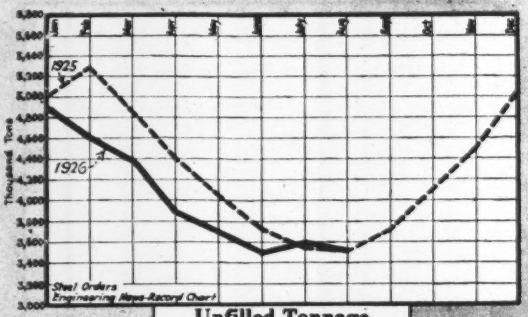


Net Price of Portland Cement
Car Lots, F.o.b. Chicago

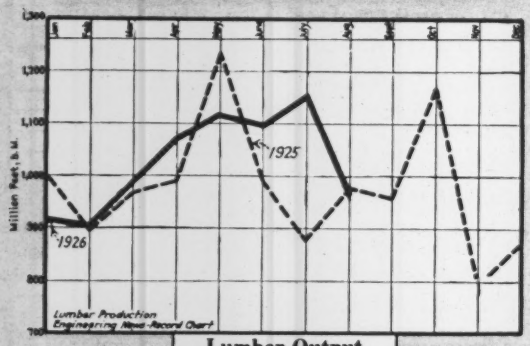
Monthly Statistics of the Construction Industry



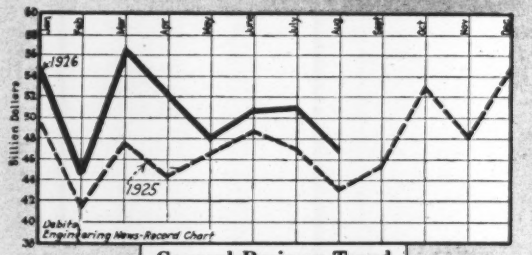
Price of Brick
At Dock, New York



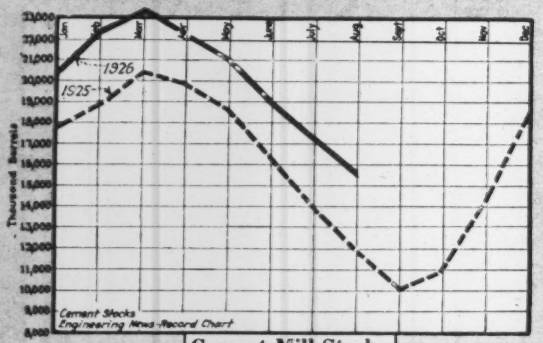
Unfilled Tonnage
On Books of U. S. Steel Corp.



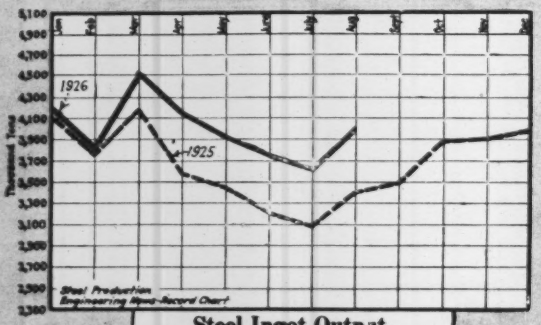
Lumber Output
Nat. Lumber Mfrs. Assn.



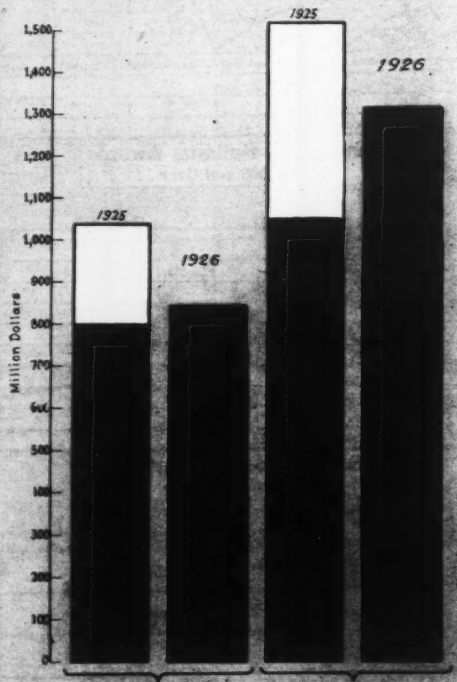
General Business Trend
Bank Debits—Federal Reserve



Cement Mill Stocks
Bureau of Mines



Steel Ingot Output
Gross Tons; Am. Iron and Steel Inst.



Public—Contracts—Private
Jan. 1 to date
Reported by E. N.-R.

Engineering Construction Contracts, Jan. 1 to Oct. 1 17 per Cent Ahead of Same Period Last Year

Similar Gain in Projected Buildings

CONTRACTS awarded on engineering construction projects, Jan. 1 to Oct. 1, 1926, for the entire United States, reached the unprecedented total of $2,178,579,000, against $1,848,907,000 for the corresponding period last year.

These operations embrace everything at or above the following minimum in each class: Water-works and excavating projects, $15,000; other public works, $25,000; industrial buildings, $40,000; commercial, educational, religious and other buildings, $150,000.

In engineering construction at least, 1926 is evidently destined to be the record year in the history of the industry. The lead of 17 per cent or more, this year over last, with only three more months to go, justifies this belief.

All classes of construction show substantial gains over the cumulative totals at this time last year, except the one comprising excavation, drainage, irrigation, levee, river and harbor work.

September contract totals, corrected for cost inflations (labor and materials) occurring between 1913 and 1926 and reduced to percentages of the 1913 base, show actual volume of lettings as follows:

1913	100	1920	80
1914	95	1921	109
1915	116	1922	149
1916	145	1923	166
1917	116	1924	159
1918	145	1925	262
1919	113	1926	227

Total value of contracts, Jan. 1 to Oct. 1, by classes, follows:

Class	1926 (000) Omitted	1926 (000) Omitted	Per Cent Gain (+) or Loss (—) Compared With 1925
Federal Gov't	$44,162	$26,523	+69
Industrial Bldgs.	243,146	165,610	+47
Bridges	65,677	50,451	+30
Sewers	76,032	62,888	+21
Commercial Bldgs.	1,118,118	963,748	+16
Streets and Roads	393,724	347,511	+13
Water-works	48,017	46,754	+ 2
Miscellaneous	169,101	167,605	+ 1
Excavating, etc	20,602	24,606	—16

Seventeen out of the forty-eight states showed more than seasonal falling off in contract letting during the last month. Names of these states are as follows: Maine, New York, Maryland, West Virginia, North Carolina, South Carolina, Florida, Alabama, Mississippi, Kentucky, Ohio, Illinois, North Dakota, South Dakota, Nebraska, Oklahoma, and Nevada.

Building projects definitely reported as proposed, for the entire U. S., at the minimums mentioned, Jan. 1 to Oct. 1, 1926, totaled $2,400,521,000. This represents a gain of 17 per cent, compared with the corresponding period last year.

Construction other than buildings, for the country as a whole, proposed during the period Jan. 1 to Oct. 1, 1926, totaled $1,845,200,000, a gain of 26 per cent, compared with same months in 1925.

A sustained heavy volume of engineering construction awards is assured for several months to come, according to these proposed jobs.

Value of Contracts Let in the United States and Canada During September, 1926

	New England	Middle Atlantic	South	Middle West	West of Mississippi	Far West	United States	Jan. 1 to Date U. S.	Canada
Waterworks	$1,628,000	$511,000	$158,000	$2,177,000	$1,294,000	$2,948,000	$8,716,000	$48,017,000	$225,000
Sewers	859,000	3,378,000	349,000	3,147,000	1,756,000	1,782,000	11,271,000	76,032,000	375,000
Bridges	525,000	5,668,000	2,613,000	1,202,000	1,522,000	715,000	12,245,000	65,677,000	45,000
Excavating, drainage, irrigation	83,000	447,000	189,000	474,000	.....	33,000	1,136,000	20,602,000	831,000
Streets and roads	2,981,000	12,024,000	8,920,000	12,881,000	10,250,000	8,156,000	55,212,000	393,724,000	1,430,000
Industrial building	3,255,000	3,531,000	2,815,000	10,406,000	7,485,000	2,087,000	29,579,000	243,146,000	50,000
Commercial building	22,259,000	41,244,000	7,102,000	30,573,000	24,579,000	15,453,000	142,210,000	1,118,118,000	5,014,000
Federal Government	194,000	1,067,000	1,106,000	873,000	2,357,000	102,000	5,699,000	44,162,000	.....
Unclassified	1,836,000	2,157,000	102,000	1,477,000	3,098,000	1,619,000	10,299,000	169,101,000	284,000
September, 1926	$33,620,000	$70,027,000	$24,354,000	$63,210,000	$52,341,000	$32,905,000	$276,457,000	$2,178,579,000	$8,254,000
August, 1926	17,977,000	76,648,000	19,767,000	65,070,000	38,393,000	25,161,000	243,016,000	.....	7,444,000
September, 1925	22,386,000	94,338,000	50,621,000	34,443,000	38,750,000	8,270,000	248,808,000	.....	3,321,000
January 1 to date, 1926	188,790,000	662,994,000	226,625,000	533,042,000	341,443,000	225,685,000	2,178,579,000	.....	95,096,000
January 1 to date, 1925	153,355,000	664,654,000	183,220,000	321,883,000	325,770,000	200,025,000	1,848,907,000	.....	62,843,000

Labor Rates and Conditions Throughout the Country

Employment Outlook Favorable

PROSPECTS of full fall employment in most of the major industries are particularly bright, according to reports received from *E. N-R.* correspondents.

In construction, the busy season for the finishing crafts is about to begin as usual. Volume of projected work, however, is sufficiently large to insure active employment in the starting trades throughout the current quarter.

Bonus payments and actual shortages of skilled men will disappear but not to the accompaniment of appreciable unemployment, it is believed.

As a general rule, expansion and contraction in volume of contract letting occurs in inverse proportion to rise and fall in construction cost. Charts on p. 600 show that during the first half of the current year, cost was below and volume of lettings above, the respective 1925 lines. The last half of 1926, however, will probably see the situation reversed. Current costs are but a fraction of one per cent above those of a month ago, while volume of contracts shows a normal seasonal decline.

Gains in factory employment and pay-rolls during the last month, are compared with lower wholesale prices of commodities and a downward tendency in living costs. When it is considered that skilled construction workers get, on the average, about 0.7 per cent more than they did a month ago, while common laborers wages are 0.9 per cent lower, the whole situation may be described as being distinctly in favor of wage earners in the manufacturing and skilled building trades.

Serious strikes have been on the decline since early in August, leaving only five major disturbances, unsettled at the present time. Carpenters in San Francisco and Philadelphia; electricians, steam fitters, elevator constructors and ironworkers (ornamental and structural) in Chicago; electrical workers in New York and hoisting engineers in Boston, are still on strike. The open-shop question forms the chief cause of most of the trouble.

Following the walkout of the five trades in Chicago, which occurred more than a month ago, comes a new wage schedule, effective Oct. 1, involving twelve crafts and also common laborers. The following were advanced from $1.37½ to $1.50 per hr.: architectural ironworkers, boiler makers, carpenters, cement finishers, composition floor finishers, hoisting engineers (cable and others), marble setters, structural ironworkers, and terrazzo mechanics. Caisson diggers were advanced from $1.17½ to $1.20; caisson windlass operators, from $1.02½ to $1.05; and common laborers, from 87½c. to 90c. per hr.

The master plumbers' association of Chicago, which travels under the name of a "sanitary engineering" association, has made a closed-shop agreement with the plumbers' union. It thus breaks away from the citizens' committee to enforce the Landis Award, which was organized in 1921 to provide for open-shop work when several unions in the building trades refused to accept the wage awards and trade rules drafted by Judge Landis.

San Francisco carpenters' strike, started Apr. 1 in protest against the open shop, is still in force. Continuation of the violence which characterized this strike at its inception, is reported.

Boston hoisting engineers are still on strike in an effort to unite the operators in sand and gravel pits with their organization.

New York electrical workers belonging to Local No. 3 of the Inside Electrical Workers Union went on strike

Current Building Trades Wage Rates Per Hour

(Higher rates indicated by +, decreases by —)

Cities	Bricklayers	Carpenters	Hoisting Engineers	Hod Carriers	Pile Drivers	Structural Iron Workers	Common Labor
Atlanta	$1.12½	$0.70	$0.70	$0.50	.....	$0.75	$0.25@.30
Baltimore	1.62½@1.75	1.00@1.10	1.00@1.12½	1.00	$0.65	1.12½	.40
Birmingham	1.00@1.50	+.40@1.05	.75@1.00	.50@.75	.....	.75@1.75	.20@.40
Boston	1.40	1.25	1.25	.79	1.15	1.25	.50@.75
Cincinnati	1.50	1.31¼	1.31¼	.95	1.31¼	1.31¼	.45@.55
Chicago	1.62½	+1.50	+1.50	+.90	1.37½	+1.50	+.90
Cleveland	1.50	1.25	1.30	.87½@1.10	1.10	1.50	.87½
Dallas	1.62½	1.12½	1.00	.40@.75	1.00	1.00	.30@.50
Denver	1.62½	1.25	1.12½@1.18¾	.81¼@.87½	1.00	1.15⅝	.40@.55
Detroit	1.50	.90@1.15	.85@1.00	.90	.85@1.00	1.12½	.50@.60
Kansas City, Mo	1.50	+1.17½	1.25	.90	1.12½	1.25	.35@.75
Los Angeles	+1.50	1.00	1.00	+1.12½	.80	1.00	.50
Minneapolis	1.25	.87½@.95	.87½	.75	....	1.00	.45@.60
Montreal	1.00@1.25	.75	.60	.40	.50	.75	.30@.35
New Orleans	1.25	.90	1.00	.75	.85	1.25	.35@.40
New York	1.75	1.50	1.75	1.12½	1.00@1.12½	1.75	.90⅝
Philadelphia	1.50@1.62½	1.12½@1.25	1.02¼	1.12½	1.00	1.12½@1.25	.45@.50
Pittsburgh	1.62½	1.50	1.37½@1.50	1.12½	....	1.50	.80
St. Louis	1.75	1.50	1.50@1.65	1.15@1.25	1.25	1.50	.45@.75
San Francisco	1.25	1.00	1.00	.81¼	1.00	1.12½	.50@.55
Seattle	1.37½	1.12½	1.00@1.12½	1.00	1.00@1.12½	1.12½	.50@.62½

Sept. 3, refusing to install fixtures made by non-union labor.

Philadelphia carpenters are striking on several projects, in an effort to establish closed-shop conditions.

St. Louis painters returned to work at $1.40 per hr., following a strike started last spring, with the understanding that the scale would be increased to $1.45 in the autumn. Sheet metal workers were advanced to $1.50 per hr. Oct. 1, from the former rate of $1.37½. Asbestos workers are demanding $1.50 per hr., against the present wage of $1.25. The painters are the only craftsmen, affiliated with the St. Louis building Trades Council, who receive a rate under $1.50 per hr.

Monthly Prices of Construction Materials

Ups and Downs of the Market

PRICES of construction materials are steady with few important changes from the Sept. 1 levels. Firmness, with upward tendencies, is noted in pig-iron, scrap, railway steel, concrete aggregates, wire and cut nails and explosives. The declines occurred mainly in railway ties, cast-iron pipe, lime, lumber, linseed oil and manila rope. New base gauge No. 24 on black and galvanized steel sheets.

Pig Iron—Firmness prevails in pig iron with advances in spots. Current prices will probably hold for at least another week. The decline, noted in the table, on No. 2 foundry iron at Birmingham, is a purely local adjustment.

Railway Supplies—Increased buying of railway steel is anticipated as the season advances. Light and re-rolled rails and section angle bars moved up during the month at Pittsburgh mills; price fluctuations appear in other track supplies at various points. White and red oak and sap pine-cypress ties 7-in. x 9-in. x 8½ ft., declined 5c. during the month.

Pipe—Seasonal decline in cast-iron pipe demand is unusually slight this year; prices, however, dropped $1 per ton from the Sept. 1 level in the Northeastern section of the country. Sewer pipe shows very little fluctuation and no changes occurred, during the month, in the other items on the pipe list.

Road and Paving Materials—Road oils, asphalt, paving stone and flagging remain unchanged from the Sept. 1 levels. Slight fluctuations are reported in curbing and wood block paving in the West.

Sand, Gravel and Crushed Stone—Most of the changes that occurred in prices of aggregates during the month were in an upward direction. See p. 606 for revised prices on crushed slag.

Lime and Cement—Considerable fluctuation developed in lime during the last month. Declines are reported in Boston, Detroit, Denver and San Francisco. Kansas City and Minneapolis markets, however, turned in the opposite direction. Portland cement prices were uniformly steady during the month, with no changes recorded in forty-six localities reporting to E. N.-R.

Brick and Hollow Tile—Brick dropped $1 per M. in Philadelphia and St. Louis, during September and rose 50c. at Kansas City, Mo. The general price level for brick is very slightly above that of a year ago. Hollow tile is steady in the East, with changes, up and down, reported at some of the Western points but without definite price trend.

Structural Steel — September structural steel sales were heavier than those for the month preceding. Structural and bar tonnages have both contracted slightly, during the last week, yet prices have a firmer tone. Bars and shapes are $2 per 100 lb. and plates, $1.90, f.o.b. Pittsburgh mill, although as low as $1.90, in a single instance, is reported on the first two.

Lumber—Price declines are still in excess of advances, with this condition more pronounced in pine than in fir. Spruce appears firmer; no change occurred in hemlock. Last month, price recessions were confined to fir. Higher prices for the smaller sizes of pine timbers are reported in Chicago.

Linseed Oil—The tendency is downward in prices of raw oil at the present time. Compared with Sept. 1, the New York market is down 9¾c. per 7½-lb. gal. and Chicago, 2c. per gal. Minneapolis shows less tendency to fluctuate.

Scrap—Advancing tendencies are noted in steel scrap in the Youngstown and Birmingham districts, Pittsburgh, however, reports a drop of 50c. per ton. Prices at New York are on a net ton basis.

Miscellaneous—Wire nails moved up 20c. and cut, 10c. per keg at Birmingham, during the month. Manila rope continues to decline, although Boston prices rallied during September to the extent of 0.5c. per lb.

Industry Builds on a New Plane Since the War

This important statistical study will be published here next week.

E. N.-R. Prices of Construction Materials

Price advances since last month are indicated by **heavy type**; declines by *italics*

PIG IRON—Per Gross Ton f.o.b.:

	Oct. 7	One Year Ago
CINCINNATI		
No. 2 Southern (silicon 2.25@2.75)	$24.19	$23.05
Northern Basic	20.39	22.27
No. 2 Southern Ohio (silicon 1.75@2.25)	21.39	22.77
NEW YORK, tidewater delivery		
Southern No. 2 (silicon 2.25@2.75)	27.37	27.37
BIRMINGHAM		
No. 2 Foundry (silicon 2.25@2.75)	*20.00*	19.00@19.50
PHILADELPHIA		
Eastern Pa., No. 2X (2.25@2.75 sil.)	22.76	22.26
Virginia No. 2 (silicon 2.25@2.75)	28.67	29.17
Basic	21.26	21.16
CHICAGO		
No. 2 Foundry Local (silicon 1.75@2.25)	21.75	22.00
No. 2 Foundry Southern (silicon 2.25@2.75)	25.05	25.55
PITTSBURGH, including freight charge ($1.76) from the Valley		
No. 2 Foundry Valley (silicon 1.75@2.25)	19.76	20.77
Basic	19.76	20.77
Bessemer	19.76	20.77

SCRAP—The prices following are f.o.b. per net ton paid by dealers:

	New York	Chicago	Birmingham
No. 1 railroad wrought	$13.00@$13.50	*$13.00@$13.50*	$12.00@$13.00
Stove plate	10.00@ 11.00	*14.00@ 14.50*	14.00@ 14.50
No. 1 machinery cast	16.00@ 17.00	**16.50@ 17.00**	17.00@ **17.50**
Machine shop turnings	9.25@ 9.75	*7.25@ 7.75*	8.00@ **8.50**
Cast borings	10.00@ 10.25	**10.50@ 11.00**	8.00@ **9.00**
Railroad malleable	16.00@ 16.50*	*15.25@ 15.75*	16.00@ **17.00**
Re-rolling rails	12.50@ 13.00	*15.00@ 15.50*	15.00@ 16.00
Re-laying rails	23.00@ 24.00		21.00@ 22.00
Heavy melting steel	11.50@ 12.00	*12.00@ 12.50*	13.00@ **14.00**

*Gross ton.

Railway Supplies

STEEL RAILS—The following quotations are per ton f.o.b. for carload or larger lots. For less than carload lots 5c. per 100 lb. is charged extra:

	Pittsburgh				
	Oct. 7	One Year Ago	Birmingham	Chicago	St. Louis
Standard bessemer rails	$43.00	$43.00	$43.00	$43.00	.....
Standard openhearth rails	43.00	43.00	43.00	43.00	$51.00
Light rails, 8 to 10 lb.	.....	32@34	34@36	1.80@1.90*	2.05*
Light rails, 12 to 14 lb.	.....	32@34	34@36	1.80@1.90*	1.88*
Light rails, 25 to 45 lb.	**34@36**	32@34	34@36	1.80@1.90*	1.84*
Re-rolled rails	**30@33**	27@30	30.00	34@36	.....

*Per 100 lb.

RAILWAY TIES—For fair-sized orders, the following prices per tie hold:

	6 In. x 8 In. by 8 Ft.	7 In. x 9 In. by 8½ Ft.
Chicago, white oak, plain	$1.45	$1.83
Chicago, empty cell creosoted	1.90	2.45
Chicago, zinc treated	1.70	2.20
San Francisco, green Douglas fir	.84	1.14
San Francisco, empty cell creosoted, Douglas fir	1.70	2.25
St. Louis, white oak, plain	1.20	*1.45*
St. Louis, zinc treated	1.60	*1.85*
St. Louis, red oak, plain	1.10	*1.35*
St. Louis, sap pine-cypress	.95	*1.20*
Birmingham, white oak	1.25	1.45

TRACK SUPPLIES—The following prices are base per 100 lb. f.o.b. Pittsburgh mill for carload lots, together with the warehouse prices at the places named:

	Pittsburgh					
	Oct. 7	One Year Ago	Chicago	St. Louis	San Francisco	Birmingham
Standard spikes, ⅝-in. and larger	$2.80@$2.90	$2.70@2.80	$3.55	$3.65	*$3.80*	$3.00
Track bolts	3.90@4.25	3.90@4.15	4.55	4.40	*5.35*	3.90
Standard section angle bars	2.75@**2.95**	2.75	3.40	3.25@3.75	3.60	4.15

Pipe

WROUGHT PIPE—The following discounts are to jobbers for carload lots at Pittsburgh mill:

BUTT WELD

Inches	Steel Black	Steel Galv.	Inches	Iron Black	Iron Galv.
1 to 3	62	50½	1 to 1½	30	12

LAP WELD

2	55	43½	2	23	7
2½ to 6	59	47½	2½	26	11
7 and 8	56	43½	3 to 6	28	13
9 and 10	54	41½	7 to 12	26	11
11 and 12	53	40½			

BUTT WELD, EXTRA STRONG, PLAIN ENDS

1 to 1½	60	49½	1 to 1½	30	14
2 to 3	61	50½			

LAP WELD, EXTRA STRONG, PLAIN ENDS

2	53	42½	2	23	9
2½ to 4	57	46½	2½ to 4	29	15
4½ to 6	56	45½	4½ to 6	28	14
7 and 8	52	39½	7 and 8	21	7
9 and 10	45	32½	9 to 12	16	2
11 and 12	44	31½			

STEEL PIPE—From warehouses at the places named the following discounts hold for welded steel pipe:

	Black			
	New York	Chicago	Birmingham	St. Louis
1 to 3 in. butt welded	53%	54%	62%	49%
2½ to 6 in. lap welded	48%	51%	59%	46%

	Galvanized			
	New York	Chicago	Birmingham	St. Louis
1 to 3 in. butt welded	39%	41%	50½%	36%
2½ to 6 in. lap welded	35%	38%	47½%	33%

Malleable fittings, Classes B and C, banded, from New York stock sell at list plus 4% less 5%. Cast iron, standard sizes, 36—5% off.

CAST-IRON PIPE—The following are prices per net ton for carload lots:

	Birmingham	Burlington, N. J.	New York Oct. 7	New York One Year Ago
4 in.	$44.00	*$53.00@54.00*	*$55.60@56.60*	$54.60@55.60
6 in. and over	40.00	*49.00@50.00*	*51.60@52.60*	50.60@51.60

	Pittsburgh	Chicago	St. Louis	San Francisco
4 in.	$52.60	$52.20	$49.60	$54.00
6 in. and over	48.60	48.20	45.60	50.00

Gas pipe and Class "A," $4 per ton extra.

CLAY DRAIN TILE—The following prices are per 1,000 lin.ft.:

Size, In.	New York Oct. 7	New York One Year Ago	St. Louis	Birmingham	San Francisco	Dallas
3	$45.00	$48.00	$40.00	$45.00	.....	$73.00
4	55.00	50.00	40.00	56.00	$76.50	110.00
5	.....	.....	.....	80.00	97.75	118.00
6	90.00	92.00	70.00	100.00	127.50	150.00
8	160.00	160.00	170.00	165.00	212.50	210.00

SEWER PIPE—The following prices are in cents per foot for standard pipe in car load lots, f.o.b., except as otherwise stated:

Size, In.	New York Delivered	Pittsburgh	Birmingham	St. Louis	Chicago	San Francisco	Dallas
3	.....	$0.088	$0.10	.....	$0.09	$0.12	.....
4	.....	.088	.10	$0.10	.09	.15	$0.15
5	.....	.121	.135	.....	.13½	.18	.18
6	$0.24	.121	.21	.14	.13½	.21	.21
8	.43	.198	.315	.225	.21	.30	.325
10	.50	.231	.45	.315	.31½	.42	.476
12	.65	.297	.54	.405†	.40½	.56	.612
15	1.08†	.396	.75	.675†	.54	.92	1.02
18	1.55†	.55	.90	.945†	.75	1.32	1.53
20	1.89†	.66	1.20	.....	.90	.....	.....
21	.....	.77	1.25	1.25†	.....	.....	.....
22	2.52†	.88	1.35	.....	1.20	.....	1.564
24	2.84†	.99	2.665	1.62†	1.35	2.16	2.04
27	4.65†	2.405	2.952	2.45†	2.75	3.00	3.34
30	5.16†	2.664	3.96	3.00†	3.75	3.60	4.06
33	6.98†	3.60	4.51	3.55†	4.50	....	4.99
36	8.00†	4.10	5.06	3.95†	5.00	.....	5.42

	3	5	8	12	24	36
Boston	$0.125	*$0.185*	*$0.27*	*$0.56*	$2.00†	$5.50†
Minneapolis	.....	.....	.25	.45	1.50†	4.56†
Denver	.135*	.18*	.27	.47	1.70	.....
Seattle	.14	.....	.35	.72†	2.60†	.....
Los Angeles	.1675	.186	.2825	.504	1.74	.....
New Orleans	.116*	.277*	.295	.463	1.785	.....
Cincinnati	.105	.1575	.245	.4725	1.575	4.715
Atlanta	.10*	.15*	.25	.425	1.62	.....
Montreal	.....	**.50**	**.90**	1.35	4.50	.....
Detroit	.111	.1665	.259	.4995	1.665	3.7925†
Baltimore	.111	.166	.259	.499	1.665	4.92
Kansas City, Mo.	.15	.21	.29	.52	1.90†	3.80†
Philadelphia	.11	.16	.26	.42	1.50	3.70

*4-in., 6-in., 9-in., respectively. †Double Strength.

Road and Paving Materials

ROAD OILS—Following are prices per gallon in tank cars, 8,000 gal. minimum f.o.b. place named:

		Oct. 7	One Year Ago
New York, 45% asphalt	(at terminal)	$0.065 @$0.07	$0.065 @$0.07
New York, 65% asphalt	(at terminal)	.0675@ .0725	.0675@.0725
New York, binder	(at terminal)	.07 @ .075	.07 @.075
New York, flux	(at terminal)	.07 @ .075	.07 @.075
New York, liquid asphalt	(at terminal)	.07 @ .075	.07 @.075
St. Louis, 40@50% asphalt		.055	.05
St. Louis, 50@60% asphalt		.0565	.051
Birmingham, 55% asphalt		.0475	.0475
Dallas, 45% asphalt		.0495	.05
Dallas, 50% asphalt		.1455	.046
Dallas, binder		.061	.062
San Francisco, binder, per ton		12.00*	13.50*

* F.o.b. Oleum, Cal. Freight to San Francisco, 80c. per ton.

E. N.-R. Prices of Construction Materials

ASPHALT—Price per ton in packages (350-lb. bbls. or 425-lb. drums) and in bulk in carload lots, f.o.b. points listed:

	Package	Bulk
New York (*Texas*)	$23.00	$18.50
Boston (*Mexican*)	23.00	18.50
Chicago (*Texas*)	27.00	22.00
San Francisco, *f.o.b. refinery*, Oleum, Cal.	18.00	12.00
Dallas (*Texas*)	27.10	21.10
Seattle, *"D" grade, California, f.o.b. Richmond*	19.50	13.50
Denver (*California*)	24.00	.....
Minneapolis, *f.o.b. Twin Cities (Standard)*	27.60	21.60
St. Louis (*Mexican*)	27.00	24.00
Baltimore (*Standard Oil*) (*f.o.b. refinery*)	22.50	18.50
Montreal (*Imperial*)	27.00	22.50
Atlanta (*Mexican*)	23.40	19.40
Detroit (*Mexican*)	22.25	18.50
Cincinnati (*Kentucky Rock*)	.....	11.65
Maurer, N. J. (*Bermudez*)	30.00	.....
Maurer, N. J. (*Trinidad*)	23.00	.....
Philadelphia (*Mexican*)	20.00	18.00
Kansas City, Mo. (*Texas*)	27.30	*22.30*
Los Angeles (*"D" grade, California*)	*18.00	*12.00
Birmingham (*Mexican*)	27.00	21.00
New Orleans (*Mexican*)	20.00	17.00

* F.o.b. El Segundo Refinery. Drums used in New York.

NOTE—Barrels or drums are optional in most cities. About 6 bbls. to the ton, and from 4 to 5 drums; 200 to 300 gal. to the ton.

PAVING STONE—

New York (grade I)	5-in. granite, 30 blocks per sq.yd.	$147.00	per M.
San Francisco	Basalt block 4x7x8	70.00	per M.
Chicago	about 5x8x5 dressed	3.60	per sq.yd
	about 5x8x5 common	3.25	per sq.yd.
Boston	5-in. Granite	135.00	per M.
Atlanta	Granite	2.50	per sq.yd.
Detroit	5-in. Granite	3.00	per sq.yd.
Baltimore	Granite	2.85	per sq.yd.
Montreal	Granite	104.75	per M.
New Orleans	Granite, 4x8x4	2.75	per sq.yd.
Cincinnati	Granite	135.00	per M.
St. Louis	Granite, 4x8x4	1.65	per sq.yd.
Kansas City	Granite	3.15	per sq.yd.
Philadelphia	Granite	3.90@4.25	per sq.yd.
Minneapolis	Sandstone	2.74	per sq.yd.

FLAGGING—

New York	Bronx, 4 ft. wide	$0.24 per sq.ft.
	Manhattan, 4 ft. wide	.24 per sq.ft.
	Queens, 5 ft. wide	.26 per sq.ft.
	6x24-in. cross-walk	1.30 per lin.ft.

CURBING—*New York*: Bluestone per lin.ft., f.o.b. barge New York, 5x16 in., 88c.; *St. Louis*: Class "A" straight, delivered, 5x18 in., *85c.* per lin.ft.; roundings, *$1.35*. *Birmingham*: Limestone, 5x18-in., $1.05 per lin.ft.

WOOD BLOCK PAVING—

	Size of Block	Treatment	Per Sq.Yd.
New York	3	16	$2.40
New York	3½	16	2.70
Boston	3½	18	2.45
Chicago	4	16	2.25
Chicago	3½	16	2.10
St. Louis	3½	16	2.40
St. Louis	4	16	2.75
Seattle	4	16	Off market
Minneapolis	3½	16	**2.49**
Atlanta	3½	16	2.00
New Orleans	3	16	2.20
New Orleans	3½	16	2.30
New Orleans	4	16	2.40
Dallas	4	18	3.90
Baltimore	3½	16	None used
Montreal	4	16	4.50
Detroit	3	16	1.94
Detroit	4	16	.....
Cincinnati	3½	16	2.35
Kansas City	4	16'	2.50
Philadelphia	4	16	None used

Construction Materials

SAND AND GRAVEL—Price for cargo or carload lots to contractor f.o.b., per cu.yd. is as follows:

	Gravel 1½ In.		Gravel ¾ In.		Sand	
	Oct. 7	One Year Ago	Oct. 7	One Year Ago	Oct. 7	One Year Ago
New York (*alongside dock*)	$1.75	$1.75	$1.75	$1.75	$1.00	$1.00
Denver	1.90	1.90	1.90	1.90	1.00	1.00
Chicago	1.60	1.57½	1.60	1.57½	1.40	1.47½
St. Louis	1.45	1.45	**1.65**	1.45	.95	1.18
Seattle	1.50	1.50	1.50	1.50	1.50	1.50
Dallas	2.38	2.38	2.38	2.38	2.00	2.00
Minneapolis	1.65*	1.65*	1.65*	1.65*	1.25	1.25
Cincinnati	1.30†	1.40†	1.30†	1.40†	1.05†	1.35†
San Francisco	1.80	2.15	1.80	2.15	1.40	1.50
Boston	1.50†	1.50†	1.50†	1.50†	1.00†	1.00†
New Orleans	3.00	2.60	3.00	2.60	1.80	1.75
Los Angeles	1.15†	.85*†	1.15†	.85*†	1.10†	.50*†
Atlanta	1.90†	2.20†	1.90†	2.20†	1.60†	1.65†
Detroit	1.45†	2.02	1.35†	2.02	1.10†	1.62
Baltimore	1.40	1.40	1.60	1.60	.70*†	.70*†
Montreal	1.25†	1.25†	1.50†	1.25†	1.25†	1.25†
Birmingham	2.00	2.00	2.00	2.00	**1.50**	1.50
Philadelphia	2.10	2.10	2.10	2.10	1.50	1.50
Kansas City, Mo.	4.00‡	4.00‡	4.00‡	4.00‡	.66*†	.66*†

New York—Grits, $1.75 per cu.yd.; ready mixed $1.85.
* At pit † Per ton. ‡ Joplin chats.

CRUSHED STONE—Price for cargo or carload lots, per cu.yd. f.o.b. city, is as follows:

	1½ In.		¾ In.	
	Oct. 7	One Year Ago	Oct. 7	One Year Ago
New York	$1.84	$1.75	$1.94	$1.85
Chicago	1.70	1.72½	1.87½	1.87½
St. Louis	1.83*	1.83*	**1.93***	1.83*
Dallas	2.40	2.40	2.83	2.83
San Francisco	1.70	2.15	1.70	2.15
Boston	1.60*	1.60*	1.60*	1.60*
Minneapolis	1.75	1.75	1.75	1.75
Kansas City	2.00	1.50	2.00	1.50
Denver	2.50	2.50	2.50	2.50
Seattle	3.00	3.00	3.00	3.00
Atlanta	2.50*	2.20*	2.50*	2.20*
Cincinnati	1.65*	1.90*	1.65*	1.90*
Los Angeles	1.40*	1.00*	1.40*	1.00*
Detroit	1.85@**2.00***	1.90	1.85@**2.00***	1.90
Baltimore	2.50	2.50	2.55	2.55
Montreal	1.80*	1.80*	2.00*	.....
Philadelphia	2.10	2.10	2.10	2.10
Pittsburgh	2.85	2.85	2.85	2.85
Cleveland	2.70*	3.25*	2.70*	3.25*
Birmingham	2.00	2.00	2.00	2.00

* Per ton.

CRUSHED SLAG—Price of crushed slag in carload lots, per net ton, at plant

	1½-In	¾-In.	Roofing	Sand
Youngstown District	$1.30	$1.40	$2.00	$1.30
Buffalo District	1.25	1.35	2.25	1.25
Birmingham, Ala	.90	1.25	2.05	.80
Cleveland, Ohio	1.70*	1.70*	.....	1.40*
Eastern Pa. and Northern N. J.	1.25	1.25	2.00	1.25
Western Pennsylvania	1.25	1.25	2.00	1.25
Toledo, Ohio	1.25	1.25	1.50	1.25

*Includes freight charge.

LIME—Warehouse prices:

	Hydrated, per Ton		Lump, per Barrel	
	Finishing	Common	Finishing	Common
New York	$18.20	$11.00	$3.50*	$2.10@3.00*
Chicago	20.00	18.00	.....	1.50†
St. Louis	23.50	19.50	.....	2.03*
Boston	19.00	12.50	*3.60**	2.90*
Dallas	20.00	.....	.....	1.85†
Cincinnati	16.80	11.90	.....	11.40‡
San Francisco	25.50	*21.00*	.....	1.60†
Minneapolis	25.50	21.00	.....	**1.70**†
Denver	24.00	.....	.....	2.70*
Detroit	*15.25*	*11.25*	.....	*11.75*‡
Seattle, *paper sacks*	24.00	.....	2.80†	.....
Los Angeles	30.00	25.00	3.50*	19.00‡
Baltimore	24.25	17.85	2.55†	.....
Montreal	.....	21.00	.....	10.00‡
Atlanta	23.50	13.00	2.20†	1.50†
New Orleans	24.00	15.00	2.50†	2.00*
Philadelphia	23.00	16.00	.....	.....
Kansas City	17.50	**16.00**	**2.60**†	**2.25***
Birmingham	22.50	16.00	2.40†	1.85†

* Per 280-lb. bbl. (net). † Per 180-lb. (net). ‡ Per ton.

NATURAL CEMENT—Price to dealers per bbl. for 500 bbl. or over, exclusive of bags:

	Oct. 7	One Year Ago
Minneapolis (Rosendale)	$2.80	$2.80
Kansas City (Ft. Scott)	1.45	1.45
Cincinnati (Utica)	1.72	1.72
Boston (Rosendale)	**2.65**	2.75
St. Louis (Carney)	*2.25*	2.35
Birmingham (Magnolia) pozzolan cement	2.40	2.40

PORTLAND CEMENT—Prices to contractors per bbl. in carload lots f.o.b. points listed *without bags*. Cash discount not deducted.

	Oct. 7	One Month Ago	One Year Ago
New York, del. by truck	$2.50@$2.60	$2.50@$2.60	$2.50@$2.60
New York, alongside dock to dealers	2.15	2.15	2.15
Jersey City	2.33	2.33	2.33
Boston	2.30	2.30	2.40
Chicago	2.10	2.10	2.20
Pittsburgh	2.09	2.09	2.19
Cleveland	2.29	2.29	2.39
Detroit	2.15	2.15	2.35
Indianapolis	2.29	2.29	2.39
Milwaukee	2.25	2.25	2.35
Duluth	2.09	2.09	2.19
Peoria	2.27	2.27	2.37
Cedar Rapids	2.34	2.34	2.44
Davenport	2.29	2.29	2.39
St. Louis	2.20	2.20	2.30
San Francisco	2.31	2.31	2.31
New Orleans	2.30	2.30	2.40
Minneapolis	2.32	2.32	2.42
Denver	2.85	2.85	2.84
Seattle	2.65	2.65	2.65
Dallas	2.05	2.05	2.05
Atlanta	2.35	2.35	2.25
Cincinnati	2.37	2.37	2.47
Los Angeles	2.36	2.36	2.52
Baltimore	2.50	2.50	2.50
Birmingham	2.40	2.40	2.40
Kansas City, Mo	2.35	2.35	2.30
Montreal	1.15	1.15	1.80
Philadelphia	2.41	2.41	2.41
St. Paul	2.32	2.32	2.42
Toledo	2.20	2.20	2.40

NOTE—Bags 10c. each, 40c. per bbl.; 20c. each in Canada, 80c. per bbl.

Current mill-prices per barrel in carload lots, without bags, to contractors:

Buffington, Ind	$1.85	Hudson, N. Y.	$1.95
Universal, Pa	1.85	Leeds, Ala	1.95
Steelton, Minn	1.90	Hannibal, Mo	1.95
Fordwick, Va	2.05	Lehigh Valley District	*1.85*
Mitchell, Ind	1.95	Wyandotte, Mich	1.90
Iola, Kan	1.85	Alpena, Mich	1.75
Mason City, Ia	1.90	Richard City, Tenn	2.05
La Salle, Ill	1.95	Kingsport, Tenn	2.05

E. N.-R. Prices of Construction Materials

TRIANGLE MESH—Price per 100 sq.ft. in carload lots:

PLAIN 4-INCH BY 4-INCH MESH

Style Number	Weight in Pounds per 100 sq.ft.	Pittsburgh Mill	Chicago District Mill	Warehouse: New York	St. Louis	Dallas	San Francisco
032	22	$0.97	$1.01	$1.39	$1.06	$1.13	$1.22
049	28	1.23	1.29	1.76	1.35	1.38	1.55
068	35	1.51	1.58	2.16	1.66	1.67	1.91
093	45	1.94	2.03	2.77	2.13	2.00	2.46
126	57	2.39	2.51	3.45	2.63	2.55	3.03
153	68	2.86	2.99	4.11	3.14	3.10	.....
180	78	3.28	3.43	5.70	3.60	3.47	.....
245	103	4.33	4.53	6.21	4.75	4.58	.....
267	119	5.00	5.24	7.19	5.50	5.26	6.35
336	138	5.80	6.07	8.35	6.37	6.11	.....
395	160	6.72	7.04	9.65	7.38	7.12	.....

PAVING

036P	17	$0.74	$0.77	$1.06	$0.81	$0.76	.....
053P	24	1.04	1.09	1.50	1.14	1.07	.....
072P	31	1.32	1.38	1.90	1.45	1.39	.....
097P	40	1.70	1.78	2.45	1.87	1.90	.....
049R	24	1.04	1.09	....	1.14	1.02	.....
067R	31	1.32	1.38	....	1.45	1.39	.....
089R	40	1.70	1.78	....	1.87	1.90	.....

In rolls, 48-, 52-, and 56-in. wide and in 150-, 200- and 300-ft. lengths. Galvanized is about 15% higher. Size of roll carried in New York warehouses, 48 in. wide x 150 ft. long, or 600 sq.ft.

EXPANDED METAL LATH—Prices in carload lots per 100 yd. for painted:

Weight in pounds	New York	Birmingham	Chicago	St. Louis	San Francisco	Dallas
2.2	$17.00	$19.50	$17.50	$17.00	$19.00	$23.50
2.5	18.50	21.50	19.00	18.50	21.00	25.00
3.0	21.50	24.50	22.00	21.50	24.50	28.50
3.4	23.50	27.50	24.00	23.50	27.00	31.00

BARS, CONCRETE REINFORCING—Current quotations per 100 lb., in carload lots, f.o.b., except at New York and St. Louis warehouses:

ROLLED FROM BILLETS

Inches	Pittsburgh Mill	Birmingham Mill	Warehouse: New York	Chicago	St. Louis	Dallas	San Francisco
½ and larger	$2.00	$2.25	$3.24	$2.60	$3.15	$2.75	$2.95
⅝	2.10	2.35	3.34	2.70	3.25	2.85	3.05
¾	2.20	2.45	3.44	2.80	3.35	2.95	3.15
⅞	2.40	2.65	3.64	3.00	3.55	3.10	3.35
1	3.00	3.25	4.24	3.60	4.15	3.75	3.95

For standard classification of extras for size and cutting of steel bars, see bar card of July 15, 1923.

ROLLED FROM RAILS

	St. Louis	Dallas		St. Louis	Dallas
½ in and larger	$2.35	$2.48	¾	$2.75	$2.88
⅝	2.45	2.58	⅞	3.35	3.48
¾	2.55	2.68	1	....	.....

BRICK—Contractors price per 1,000 in cargo or carload lots is as follows:

	Common: Oct. 7	One Month Ago	One Year Ago	Paving Block: 3-inch*	3½-inch*
New York (del.)	$20.40–22.40	$20.40–22.40	$17.50–18.00	$45.00	$51.00
New York (at dock)	17.00	17.00	14.50	.....	.....
Chicago	12.00	12.00	12.00	42.00	45.00
St. Louis, salmon (del.)	*15.00*	16.00	16.00	40.00	42.50
Denver, salmon	9@10	9@10	12.00	.....	.....
Dallas	14.10	14.10	11.60	35.00	.....
San Francisco	15.00	15.00	15.50	.....	.....
Los Angeles	10.00	10.06	11.50	(not used)	
Boston (del.)	19.00	19.00	17.50	45.00	50.00
Minneapolis (del.)	13.75	13.75	13.50	.....	.....
Kansas City	14.50	14.00	16.00	(no market)	
Seattle	15.00	15.00	15.00	.....	42.50
Cincinnati	15.50	15.50	17.00	40.00	45.00
Montreal	20.25	20.25	17.50	100.00†	.....
Detroit (del.)	14.00	14.00	16.00	38.40	41.50
Baltimore	18.00	18.00	18.00	40.00	45.00
Atlanta	10.50	10.50	10.50	40.00	.....
New Orleans	15.00	15.00	15.00	.....	50.00
Birmingham	14.50	14.50	12.50	40.00	45.00
Philadelphia	*18.00*	19.00	15@19	40.00	50.00
Pittsburgh (del.)	16.00	16.00	16.00	.....	.....
Cleveland	12@14	12@14	14.00	.....	.....

*For paving blocks 3x8½x4 and 3½x8½x4 respectively. †Imported.

HOLLOW TILE—Price per block in carload lots to contractor for hollow building tile.

	New York: Oct. 7 on Trucks*†	One Year Ago	Chicago	Philadelphia	St. Louis	San Francisco†	Perth Amboy N. J., Factory*
4x12x12	$0.1112	$0.1027	$0.88	$0.105	*$0.0685*	$0.108	.....
6x12x12	.1667	.1541	.119		.09	.156	.....
8x12x12	.1926	.1926	.165	.205	.126	.244	.....
10x12x12	.....	.....	.21	.....	.158	.....	$0.252
12x12x12	.....	.....	.233	.....	.188	.....	.312

*5 per cent off for cash. †Partition tile.

	4x12x12	8x12x12	12x12x12
Boston	$0.085	$0.175	$0.30
Minneapolis (f.o.b. cars)	.068	.1175	.205
Minneapolis (delivered)	.076	.13	.225
Cincinnati	.064	.1295	.1726
Kansas City	.088	.158	.242
Denver	.075	.155	.188
Seattle	.09	.18	.26
Los Angeles	.085	.172	.....
New Orleans	.13	.20	.35
Detroit	.0707	.1326	.1853
Montreal	.10	....	.....
Baltimore	.124	.268	.....
Atlanta	.0895	.1837	.....
Dallas	.112	.19	.31
Birmingham	.11	.124	.255
Pittsburgh	.068	.128	.179
Cleveland	.062	.12	.....

STRUCTURAL MATERIAL—Following are base prices per 100 lb in carload lots, f.o.b. mill, Pittsburgh and Birmingham, together with quotations in less-than-carload lots from warehouses at places named:

	Pittsburgh Mill	Birmingham	Warehouse: New York	Dallas	St. Louis	Chicago	San Francisco
Beams, 3 to 15 in.	$2.00	$2.05	$3.34	$4.15	$3.25	$3.10	$3.30
Channels, 3 to 15 in.	2.00	2.10	3.34	4.15	3.25	3.10	3.30
Angles, 3 to 16 in., ¼ in. thick	2.00	2.10	3.34	4.15	3.25	3.10	3.30
Tees, 3 in. and larger	2.00	2.10	3.34	4.15	3.35	3.10	3.30
Plates, ¼ in. thick and heavier	1.90	2.00	3.34	4.15	3.25	3.10	3.30

RIVETS—The following quotations are per 100 lb.:

STRUCTURAL

	Pittsburgh Mill	Warehouse: New York Oct. 7	New York One Yr. Ago	Chicago	St. Louis	San Francisco	Dallas
½ in.	$2.50@2.60	$4.20	$4.50	$3.50	$3.65	$5.00	$4.75

CONE HEAD BOILER

½ in.	2.90	$4.40	$4.70	$3.70	$3.85	$5.20	$5.00
⅝ and ¾	3.05	4.55	4.85	3.80	4.20@4.45	5.35	5.15
⅞ and 1	3.30	4.80	5.10	4.05	4.60	5.60	5.50

NAILS—The following quotations are per keg from warehouse:

	Pittsburgh Mill	Birmingham	Chicago	San Francisco	Dallas	St. Louis	Montreal
Wire	$2.65	$2.85	$3.05	$3.75	*$4.00*	*$2.85*	$4.95
Cut	2.80	2.90	....	5.00	5.00	*2.95*	5.00

SHIP SPIKES—Current prices per 100 lb.:

In.	San Francisco Galv.	San Francisco Black	Seattle Black
½	$7.50	$5.75	$7.75
⅝	7.05	5.30	5.65
¾	6.90	5.15	5.50

Pittsburgh base in lots of 200 kegs or more, $3.25.

PREPARED ROOFINGS—Slate-surfaced roofing in rolls of 108 sq.ft. costs $2.31 per roll to contractors in carload lots f.o.b. New York.

Single shingles, slate finish, cost $6.49 per square (sufficient to cover 100 sq.ft.) in carload lots, f.o.b. New York. Strip shingles (4 in 1) f.o.b. New York, in carload lots to contractors, $5.09 per square.

ROOFING MATERIALS—Prices f.o.b. New York, to contractors in carload lots:

Tar felt (14 lb. per square of 100 sq.ft.) per ton	$72.80
Asphalt coating per bbl.	17.00
Asphalt felt, per ton	74.20

WINDOW GLASS—United inches, 25, bracket size 6x8 to 10x15, single thickness "AA," 83 per cent; "A," 87 per cent; "B," 89 per cent. Double thickness "AA," 82 per cent; "A," 86 per cent; "B," 89 per cent discount from jobbers list at New York warehouses.

SHEETS—Quotations are per 100 lb. in various cities from warehouse also the base quotations from mill:

Blue Annealed	Pittsburgh Large Mill Lots	St. Louis	Chicago	San Francisco	New York
No. 10	$2.30@$2.40	$3.60	$3.50	$3.90	$3.89
No. 12	2.35@2.45	3.65	3.55	3.95	3.94
No. 14	2.40@2.50	3.70	3.60	4.00	3.99
No. 16	2.50@2.60	3.80	3.70	4.10	4.09
Black					
Nos. 18 to 20	2.80@2.90	4.25	3.75	4.70	4.15
No. 22	2.95@3.05	4.40	3.90	4.85	4.30
No. 24	3.00@3.10	4.45	3.95	4.90	4.35
No. 26	3.10@3.20	4.55	4.05	5.00	4.45
No. 28	3.25@3.35	4.70	4.20	5.15	4.60
Galvanized					
No. 10	3.15@3.25	4.55	4.10	.....	4.40
Nos. 12 to 14	3.25@3.35	4.65	4.20	5.05	4.50
No. 16	3.35@3.45	4.75	4.30	5.15	4.60
No. 18	3.50@3.60	4.90	4.45	5.30	4.75
No. 20	3.65@3.75	5.05	4.60	5.45	4.90
No. 22	3.70@3.80	5.10	4.65	5.50	4.95
No. 24	3.85@3.95	5.25	4.80	5.65	5.10
No. 26	4.10@4.20	5.50	5.05	5.90	5.35
No. 28	4.35@4.45	5.75	5.30	6.15	5.60

For galvanized corrugated sheets add 15c., all gages.

LINSEED OIL—These prices are per 7½-lb. gallon:

	New York: Oct. 7	New York: One Year Ago	Chicago: Oct. 7	Chicago: One Year Ago
Raw in barrels (5 bbl. lots)	*$0.85½*	$1.04	*$0.88*	$1.05

E. N.-R. Prices of Construction Materials

WHITE AND RED LEAD—Per 100-lb. keg, base price, f.o.b. New York:

	Dry		In Oil	
	Oct. 7	1 Yr. Ago	Oct. 7	1 Yr. Ago
Red	$15.25	$15.75	$16.75	$17.25
White	15.25	15.75	15.25	15.75

Lumber

Prices wholesale, per M. ft. b.m., to contractors in carload lots, f.o.b.

San Francisco—Prices of rough Douglas fir No. 1 common, in carload lots to contractors at yards.

	6-8 and 12 Ft.	10-16-18 and 20 Ft.	22 and 24 Ft.	25 to 32 Ft.
3x3 and 4	$26.00	$27.00	$28.00	$31.00
3x6 and 8	26.00	27.00	28.00	31.00
4x4-6 and 8	26.00	27.00	28.00	31.00
3x10 and 12	26.00	27.00	28.00	31.00
3x14	30.00	30.00	32.00	34.00
4x10 and 12	26.00	27.00	28.00	31.00
4x14	30.00	30.00	32.00	34.00

	24 Ft. and Under	25 to 32 Ft.	33 to 40 Ft.
6x10	$28.00	$30.00	$32.00
6x14	34.00	36.00	38.00
8x10	28.00	30.00	32.00
8x14	34.00	36.00	38.00

New York and Chicago—Wholesale prices to dealers of long leaf yellow pine.

	New York		Chicago	
	20 Ft. and Under L.L.Y.P.	22-24 Ft. L.L.Y.P.	20 Ft. and Under No. 1 L.L.Y.P.	Up to 32 Ft. No. 1 Douglas Fir
3x4 to 8x8	$43.00	$44.00	**$42.25**	$40.50
3x10 to 10x10	50.00	51.00	**48.25**	40.50
3x12 to 12x12	57.00	58.00	**58.25**	40.50
3x14 to 14x14	65.00	66.00	...	40.50
3x16 to 16x16	77.00	78.00	...	42.00

New York—Wholesale price of long-leaf yellow pine timbers (rough) to dealers; to contractors, delivered from lighters or cars to job, $5@$10 additional. Short-leaf pine costs $3 per M. ft. less.

Over 24 ft.—Add $1 for each additional 2 ft. in length up to 32 ft. and $1 for each additional foot from 32 to 36 ft.

Other Cities

	8x8-In. x 20 Ft. and Under			12x12-In. 20 Ft. and Under	
	P.	Fir*	Hemlock	Spruce	P.	Fir*
Boston	*$49.50*	$48.00†	$50.00	**$52.00**	$60.00	**$58.00†**
Seattle	.....	24.00	.....	.....	.....	23.00
New Orleans	35.00	.....	.....	.....	43.00	.....
Baltimore	32.50	49.25	53.00	60.00	38.00	49.75
Cincinnati	37.00	73.00	73.00	85.00	48.00	77.00
Montreal	50.00	*55.00*	.....	.....	60.00	65.00
Los Angeles	.....	.....	.....	33.00	.....	33.00
Denver	.....	36.25	34.75	34.75	.....	34.75
Minneapolis	42.50	38.25	34.50	.....	45.00	38.25
Atlanta	31.00	.....	.....	.....	34.00	.....
Dallas	56.00	.....	.....	.....	56.00	.....
Kansas City, Mo.	*40.25*	*41.00*	.....	.....	*55.25*	55.25
Birmingham	*32.00*	.....	.....	.....	34.00	.....
Philadelphia	54.00	**38.00**	38.00	45.00	65.00	**38.00**
Detroit	47.75	46.75	.....	.....	61.75	46.75
St. Louis	41.00	.....	.....	.....	53.00	.....

	1-In. Rough, 10 In. x 16 Ft. and Under			2-In. T. and Gr. 10 In. x 16 Ft.	
	P.	Fir*	Hemlock	P.	Fir*
Boston	*$45.00*	$42.00†	$45.00	$50.00	$48.00†
Seattle	.....	22.00	.....	.....	24.00
New Orleans	72.50	.....	.....	45.00	.....
Baltimore	55.00	44.00	44.00	34.00	50.00
Cincinnati	70.00	79.00	75.00	38.00	85.00
Montreal	45.00	50.00	40.00	65.00	50.00
Los Angeles	.....	27.00	.....	.....	36.00
Denver	.....	33.25	33.25	.....	31.25
Minneapolis	42.50	36.25	34.75	36.00	34.25
Atlanta	22.00	.....	.....	28.00	.....
Dallas	52.25	.....	.....	56.00	.....
Kansas City, Mo.	53.75	43.75	40.75	48.00	42.75
Birmingham	*27.00*	.....	.....	*42.00*	.....
Philadelphia	30.00	**38.00**	36.00	52.00	**37.00**
Detroit	39.75	37.00	.....	46.50	41.25
St. Louis	**43.00**	.....	.....	*29.00*	.....

Birmingham—Quotes carload lots, f.o.b. sidings; $4.00 additional per M. ft. to contractors.

Boston and Cincinnati—Prices to contractors in carload lots, f.o.b.

Denver—Quotes dealers price to contractors on large projects.

St. Louis—Wholesale price to contractors, f.o.b. cars, $2 per M.ft. additional.

Seattle—Price to contractors, delivered.

Dallas—Wholesale to contractors, $10 per M.ft. additional.

*Douglas fir. †Prime.

PILES—Prices per lineal foot, pine piles with bark on, f.o.b. New York:

Diameters	Points	Length	Barge	Rail
12 in. at butt	6 in.	30 to 50 ft.	$0.14½	$0.18½
12 in.—2 ft. from butt	6 in.	50 to 59 ft.	.19	.23½
12 in.—2 ft. from butt	6 in.	60 to 69 ft.	.21½	.25½
14 in.—2 ft. from butt	6 in.	50 to 69 ft.	.25½	.34
14 in.—2 ft. from butt	6 in.	70 to 79 ft.	.27½	.36½
14 in.—2 ft. from butt	5 in.	80 to 89 ft.	.35	.41

Miscellaneous

STEEL SHEETPILING—The following price is base per 100 lb. f.o.b. Pittsburgh, with a comparison of a month and a year ago:

Oct. 7	One Month Ago	One Year Ago
$2.25@$2.30	$2.25@$2.30	$2.25@$2.30

CONCRETE MASONRY UNITS—Standard 8x8x16-in., delivered to job, each:

Denver	$0.22	St. Louis	$0.18*
Detroit	.16	Boston	.22
New Orleans	.23	Minneapolis	.17*
New York (Brooklyn)	.18@.20	Philadelphia	.18@.20*
Pittsburgh	**.18**	*F.o.b.	

WIRE ROPE—Discounts from list price on regular grades of bright and galvanized are as follows:

	Eastern Territory New York and East of Missouri River
Plow steel round strand rope	35%
Special steel round strand rope	30%
Cast steel round strand rope	20%
Round strand iron and iron tiller	5%
Galvanized steel rigging and guy rope	7½%
Galvanized iron rigging and guy rope	+12½%

California, Oregon, Nevada and Washington: Discount 5 points less than discount for Eastern territory.

Wyoming, New Mexico and Colorado: Discount 5 points less than discount for Eastern territory.

Arizona: Discount 10 points less than discount for Eastern territory.

Montana, Idaho and Utah: Discount 10 points less than discount for Eastern territory.

North Dakota, Nebraska, Kansas, Oklahoma and Texas: Discount 5 points less than discount for Eastern territory.

MANILA ROPE—For rope smaller than ¾-in. the price is ½ to 2c. extra; while for quantities amounting to less than 600 ft., there is an extra charge of 1c. The number of feet per pound for the various sizes is as follows: ⅜-in., 8 ft.; ½-in., 6; ⅝-in., 4½; ¾-in., 3½; 1-in., 2 ft. 10 in.; 1¼-in., 2 ft. 4 in. Following is price per pound for ¾-in. and larger, in 1200-ft. coils:

Boston	**$0.215**	New Orleans	$0.23½
New York	.23	Los Angeles	.25
Chicago	.22½	Seattle	.24
Minneapolis	.24½	St. Louis	.22½
San Francisco	.22	Montreal	.17
Atlanta	.27	Detroit	.24½
Denver	.24@.25	Baltimore	.18
Cincinnati	.21	Kansas City	.25
Dallas	.30	Birmingham	.26@.27
Philadelphia	.25		

EXPLOSIVES—Price per pound of dynamite in small lots:

	Gelatin 40%	Gelatin 60%
New York	$0.265*	$0.287½*
Boston	.23	.25
Kansas City	**.22**	**.245**
Seattle	.165	.19
Chicago	.195†	.2175†
Minneapolis	.1917	.2123
St. Louis	.22	.245
Denver	.2025	.2275
Dallas	.225	**.306**
Los Angeles	.1875	.2225
Atlanta	.23	.255
Baltimore	.22	.23
Cincinnati	.22	.245
Montreal	.1675	.1895
Birmingham	.22	.24
New Orleans	**.233**	.26
San Francisco	.1625	**1925**
Philadelphia	.215	.24

*Special gelatin. †Quantities above 500. lb. and less than a ton.

CHEMICALS—Water and sewage treatment chemicals, spot shipments in carload lots, f.o.b. works:

Sulphate of aluminum, in bags, per 100 lb	$2.00@$2.10
Sulphate of copper, in bbl., per 100 lb	4.75@5.00
Soda ash, 58%, in bags, per 100 lb	1.38@1.55
Chlorine, liquid, tanks, per lb	.04@.04½
Hypochlorite of lime (bleaching powder) in drums, per 100 lb	2.00@2.10

FREIGHT RATES—On finished steel products in the Pittsburgh district, including plates, structural shapes, merchant steel, bars, pipe fittings, plain and galvanized wire nails, rivets, spikes, bolts, flat sheets (except planished), chains, etc., the following freight rates are effective in cents per 100 lb., in carloads of 36,000 lb.:

Atlanta	$0.58	Detroit	$0.29
Baltimore	.31	Kansas City	.735
Birmingham	.58	New Orleans	.67
Boston	.365	New York	.34
Buffalo	.265	Pacific Coast (all rail)	1.15*
Chicago	.34	Philadelphia	.32
Cincinnati	.29	St. Louis	.43
Cleveland	.19	St. Paul	.60
Denver	1.15*		

* Minimum carload, 50,000 lb., structural steel only; 80,000 lb., for other iron or steel products.